HUMAN ECOLOGY AND CHANGING PATTERNS OF CO-RESIDENCE IN THE VOSBERG LOCALITY, TONTO NATIONAL FOREST CENTRAL ARIZONA

By
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ABSTRACT

Archeological survey and excavation in the mountainous Vosberg locality of central Arizona has led previous investigators to propose that, during the prehistoric period from A.D. 1050 to 1250, the pattern of settlement in the locality changed from an initial condition in which habitation sites were constructed in scattered locations and composed of minimal numbers of individual structures to a subsequent condition in which individual structures came to be arranged into larger groups of aligned, contiguous units. This change is identified as an instance of the widespread Southwestern phenomenon of population aggregation, but is defined in this specific case as a change in patterns of co-residence.

Through the use of hypothetico-deductive reasoning and an ecosystemic framework, this study examines the causes underlying changing patterns of co-residence in Vosberg Valley. An explanation for increasing site size is offered through formulation of a major hypothesis which postulates that co-residential reorganization was generated as population expansion in the agricultural society necessitated intensification of productivity. Larger sites formed on lands where productivity could be increased through technological innovation and advantageous utilization of favorable environmental conditions. Analyses of archeological survey and excavation data are used to establish the validity of several secondary and supportive hypotheses drawn from the major hypothesis.

Finally, it is suggested that the general phenomenon of population aggregation might best be explained by reference to economic causal factors considered as an integral part of local or regional ecological circumstances.

ACKNOWLEDGMENTS

At a time when there are strongly divergent opinions concerning the goals of archeology, my analysis of materials from Vosberg Valley represents what I personally feel are some of the more important and informative aspects of archeological research. However, this study is very much a product of the intellectual climate in which it was conceived. It was originally written, much in its present form, as a dissertation, culminating the author's involvement in graduate studies in archeology at Arizona State University. These studies were undertaken during the late 1960's and early 1970's, a period in which archeological method and theory were subjected to constant critical scrutiny, were infused with a plethora of new ideas and concepts, and underwent what many consider to have been profound changes.

Much of the direction of the study is attributable to guidance from the members of the archeological faculty at Arizona State University, both individually and collectively. This group of scholars kept the graduate student body constantly oriented toward new developments taking place in the discipline of archeology. In turn, this orientation fostered a lively interaction among the graduate students themselves in which the new ideas were weighed and debated and eventually integrated into or rejected from each individual's conceptual milieu. Thus, I owe a debt of gratitude to both the faculty and to my fellow graduate students.

I would like to individually thank the members of my Ph.D. committee who read and commented upon several drafts of this work. They are D. G. A. Clark, Dr. A. E. Dittert, Jr., Dr. D.H. Morris, Dr. S. W. Gaines, and Dr. J. Schoenwetter. Drs. Dittert, Morris, and Schoenwetter were also involved in directing the field school sessions during which much of the data for this study was gathered. However, I feel that Dr. James Schoenwetter should be singled out for special gratitude. His thorough and detailed reading of and commentary upon each draft of this work are largely responsible for the organization and clarity of the final product, although the ideas and whatever inaccuracies exist in the work are my own.

The survey which in part serves as a data base for this study was conducted on both public and private lands. I am indebted to

Jack Rodgers for permission to conduct a survey on his property. I am equally indebted to the Tonto National Forest for issuing a permit to conduct a survey on lands under its jurisdiction. Several persons gave various degrees of assistance to the author during field survey which was conducted on an intermittent basis in the spring and summer of 1974. I wish to thank Robert Burton, Mark Raab, Logan McNatt, Martin and Shirley McAllister, Don Weaver, Bettina Rosenberg, Veronica Da Costa, Linda Richards, Russ Stafford, and Bill Reynolds. A special note of thanks is due my wife, Roseanne, who, in addition to assisting with survey, read and commented upon the later drafts of the study.

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CHAPTER I

INTRODUCTION

The archeological data base for this study derives from survey and excavation in the Vosberg locality which is a small, mountainous valley just south of the Mogollon Rim in central Arizona. Prior archeological investigation of the area has led Dittert (personal communication) to suggest that, during the 200-year period from about A. D. 1050 to 1250, settlement patterns of the inhabitants of this valley underwent certain changes. At the beginning of this period, habitation structures were constructed in scattered locations and composed of minimal numbers of individual units, but as the period progressed a pattern of aggregation began to emerge. Sites came to be larger and, though still being composed of the same kind of individual dwellings, also came to be arranged in groups of aligned, contiguous units. This change, as will be discussed later, is defined as a change in co-residence patterns; and the goal of this study is explanation of the change from a causal perspective.

Why did such a change occur? What processes underlie such a change? Where does one begin to look for possible causal variables to explain this reorganization in patterns of residence?

In order to answer these questions, it is instructive to look at certain developments in archeological methodology which took place a number of years ago. According to Parsons (1972:128), the pioneering work of Willey (1953) in the Viru Valley of Peru was the ". . . first archeological study aimed explicitly at inferring cultural processes from the regional patterning of settlement . . . ." In the Viru Valley study, Willey (1953:1) propounded the idea that

> These settlements reflect the natural environment, the level of technology on which the builders operated, and various institutions of social interaction and control which the culture maintained. Because settlement patterns are, to a large extent, directly shaped by widely held cultural needs, they offer a strategic starting point for the functional interpretation of archeological cultures.

These ideas led to a proliferation of archeological settlement pattern studies in the late 1950's, including a collection of papers on the

topic by a number of New World archeologists (Willey 1956). The 1956 volume of settlement pattern studies was appraised by the ethnologist Vogt who suggested ". . . that the concept of settlement pattern should include the ecological dimension at the outset and thereby provide the basis for . . ." related analyses focusing upon ". . . social structural inference . . ." and ". . . the study of change through time with a view to providing materials for generalizing about cultural process" (Vogt 1956:174-75).

In a recent comprehensive review of ecological anthropology, Anderson (1973:196) noted that one facet of general anthropological research has been a concern with ". . . the effect of features of the habitat, through the medium of productive organization, upon the organization of groups, stratification, leadership, and other social institutions." Though his discussion was mainly concerned with cultural anthropological studies dealing with living peoples, there is not a priori reason why archeologists cannot deal with this problem. I believe that archeologists are in an excellent position to investigate the proposed relationship between habitat and the organization of groups, and that the diachronic perspective afforded by archeological data readily lends itself to investigation of the nature of causal links between these two variables. Insofar as the variety seen in group organization among contemporary peoples has its developmental roots buried in the past, archeologists are in a rather enviable position. For, while cultural anthropologists have attempted to reconstruct the developmental history of human behavior by inferences drawn from ethnographic examples (e.g., Service 1962; Steward 1955), archeologists have always had at their disposal, through settlement patterns, a substantive record of the ways in which spatial arrangements of human communities have changed through time.

Trigger (1968:54) has divided settlement pattern studies into two basic approaches: one primarily ecological in which environment and technology are treated as the determinants of settlement patterns, and the other primarily aimed at drawing inferences concerning social, political, and religious organizational principles of prehistoric society. It is my position that we need not conceptually separate these approaches, for at least some organizational features of society should be analyzed as the direct outcome of human interaction with environmental factors through the medium of technology. In this study, the tendency toward population aggregation in Vosberg Valley is defined as a change in patterns of co-residence in which greater and greater numbers of nuclear family groups became

clustered at individual sites with the passage of time. The important aspect of my work is that it offers an explanation for this change in group spatial organization through testing of several hypotheses in which group organization is viewed as causally linked to environmental and technological factors. I have not attempted to go beyond explanation of this single aspect of social organization, but I share the opinion of Lipe (1970:86) who stated his conviction that

> The shift from a highly dispersed settlement pattern with short occupancy of small sites to a pattern of residence in large, permanent, highly nucleated, village communities was, it seems to me, a watershed in Pueblo history. It is inconceivable to me that some of the distinctive aspects of modern Pueblo social organization, such as the very tight system of social control, could have developed prior to the appearance of large, permanent, densely populated communities.

Based upon the proposition, admittedly an assumption at this time, that changes in spatial organization among human groups lead to further changes in other aspects of social organization, the logical first step is the necessity to determine the causes which underlie changes in spatial organization. A pressing archeological challenge is the need to develop methods for determining the social consequences of spatial reorganization, but an investigation of such relationships lies outside my intended purposes.

To say the least, questions of social organization have never occupied the forefront of archeological inquiry; but, following several relatively recent modifications and a few out-and-out accessions to the paradigm(s) under which archeologists operate (see Leone 1972), such questions have come to evoke ever increasing attention. Prior to 1960, the vast majority of archeological research was directed toward culture historical questions (Willey and Sabloff 1974:88-177), whether the ultimate intent of this history was simply to generate a chronology of past events or a desire to place such events in their broader functional contexts. However, since 1960, a number of archeologists have fostered the idea that archeology can and should go beyond the limited conclusions obtainable through culture historical analysis. This paradigm is still in the process of reaching maturity and has been given a number of labels (e.g., "new archeology" (Caldwell 1966), "analytical archeology" (Clarke 1968), "scientific archeology" (Watson, LeBlanc, and Redman 1971, and "processual

archeology" (Binford 1965)); but, of the various proposed labels, the term "processual" is preferred by Binford (1968) and Flannery (1967), the two leading proponents of the paradigm. These two authors have emphasized that the approach is firmly predicated on a commitment to causal explanation of past events, as opposed to description or placement of events in a chronological sequence as a final product of archeological research. Indeed, Willey and Sabloff (1974:178) have even defined the post-1960 period in American archeology as the "Explanatory Period." Stated in basic terms, processual archeology is founded on the premise that differences in human behavior across space and through time occur for specifiable reasons; explication of such underlying causal factors is a primary objective of the processual approach.

In addition to establishing explanation as a primary objective, some processualists (Binford 1964; Flannery 1968; Struever 1968) have further argued that explanation of human behavior must be sought in an interactive network which involves both man and his organic and inorganic environment, i.e., an ecosystemic framework. The components of such ecosystems are considered differentially linked in causal nexuses wherein the actions of one part of the system generate reaction and adjustment in other parts of the system. In this view, attempts to explain human behavior which ignore these systemic interactions are regarded as partial and, thus, rather poor explanations.

Explanation of changing co-residence patterns in Vosberg Valley is undertaken in a hypothetico-deductive framework, the explicit development of which has also been a topic of much recent methodological debate (e.g., Fritz and Plot 1970; Morgan 1973, 1974; Tuggle, Townsend, and Riley 1972; Watson, LeBlanc, and Redman 1971, 1974), though there have been few convincing substantive examples demonstrating the utility of hypothetico-deductive explanation through analysis of actual archeological data.

Since it is not my intention in this study to engage in theoretical debate, the foregoing discussion has been included primarily to set the theoretical climate in which the study was conceived. The primary concern of this study is substantive, but I feel that substantive and theoretical matters should not exist as separate conceptual strata: the ways we treat archeological phenomena should derive from explicit theoretical preconceptions. It is hoped that ties between these two realms will be made evident during the course of the work which follows.

Chapter II begins with a brief historical look at some of the archeological research in the Southwest related to questions of prehistoric social organization. The second subsection of Chapter II discusses some recent trends in the same area of inquiry and specifies the nature of social organizational inquiry pursued in this study. The chapter ends by defining, or outlining, a few of the terms and concepts which are basic to the problem under investigation. Chapter III introduces the Vosberg Valley area, recounts the steps leading to initial formulation of the problem at hand, and briefly summarizes other archeological investigations in and around the central part of Arizona. In Chapter IV attention is given the theoretical presuppositions on which the present analysis is based. The first subsection examines the concept of human ecology, followed by a cursory foray into the hotly debated issue of explanation in archeology. The final three subsections of Chapter IV discuss, in turn, formulation of the major hypothesis, derivation of secondary hypotheses and test implications appropriate to each, and derivation of supportive hypotheses and related test implications. In Chapter V, the chapter concerned with data analyses, archeological material from survey and excavation in Vosberg Valley is analyzed in terms of test implications drawn from the various secondary and supportive hypotheses. Chapter VI offers a summary and concluding remarks.

In reviewing current directions in archeological research in the Southwest, Longacre (1973:202) noted that the latest efforts have focused ". . . upon organizational and behavioral aspects of extinct societies . . ." and have attempted ". . . to explain changes in these extinct societies within an ecological frame of reference." The present study is conducted in this new mode, not because it is the "in thing," but because I firmly believe that it is a very meaningful direction and that we can use the archeological record as a means of scientifically testing our ideas concerning the causal factors underlying human behavioral change, with an ultimate objective of deriving valid generalizations pertaining to human behavior at all times and in all places. This study illustrates that we can move toward such a goal by combining several recently developed methodological tools into a unified approach. The widely recurrent phenomena of aggregation, or changing co-residence patterns, is segregated as a relevant problem in prehistoric human behavioral research. Investigation of this problem is undertaken in an explanatory framework wherein a number of ecologically derived hypotheses concerning the causes of co-residential change are tested with archeological data from Vosberg Valley. To my

knowledge, no one has previously offered a step-by-step, tested explanation of changing patterns of co-residence in prehistoric times. The outcome and implications of this study are explored in the concluding chapter.

CHAPTER II

SOUTHWESTERN RESEARCH RELATED TO PROBLEMS IN SOCIAL ORGANIZATION

A Brief History of Past Inquiry

In the introductory remarks, it was implied that archeological concern for prehistoric social organization is a rather recent development. To be more accurate, one should say that, in the past, questions of social organization have received attention from a very limited number of archeologists. For the most part, those few who have been concerned with social organization have approached the subject from a descriptive, historical perspective. An even smaller number of investigators, discussed below, have sought to explicate the processes underlying changes in social organization.

There are two condensed historical accounts of Southwestern archeology which are in partial disagreement concerning the place of social organizational inquiry among early investigators. Taylor (1954) has labelled the earliest period of controlled Southwestern archeology the "Cushing-Fewkes Period," dating from about 1880 to about 1915. He observed that early investigators took little notice of any kind of variability in the archeological record. To the contrary, Longacre (1970a:3) has stated, "One of the important problems facing investigators during this era was the need to explain the apparent shift from small, scattered settlements to fewer, larger towns." Taylor (1954) does allow that when and if differences were perceived in the archeological record, they sometimes were attributed to underlying differences in social organization.

Longacre (1970a) and Taylor (1954) are in agreement that an uncritical application of ethnographic analogy characterized archeological methodology during this period. They have also pointed out some of the circumstances which seemed to justify such a methodology. According to Longacre (1970a), many of the early archeologists were general anthropologists who viewed all historically known Pueblo peoples as a rather homogeneous group. Taylor (1954) argued that ethnographic work of the time did not recognize the significance of diversity present in living Southwestern Indian societies, and that archeologists generally attributed all archeological

manifestations to a single, prehistoric, undifferentiated, pan-Southwestern culture with little time depth. Under such circumstances, the goals of archeology seemed clearcut: linking of prehistoric manifestations with living Indian groups; the obvious methodological tool was direct application of ethnographic analogy. Given the prevailing state of knowledge and certain assumptions, it was felt that subsequent to describing a given archeological configuration, one could turn to Pueblo ethnography to "explain" its occurrence. Because ethnographic analogy offered such a convenient explanatory tool, these early archeologists might well be bewildered by the extraordinary importance assigned to spatial and contextual information by contemporary archeologists.

Writings during this early period dealing with social organization were largely descriptive and historical. Having noted the change from small, scattered settlements to larger villages and towns, Fewkes (1919) argued that the former represented clan organization while the latter were indicative of social groups more on the order of sodalities. Cummings (1910) reasoned that prehistorically the unit of organization must have been the clan since the clan was the basic unit of ethnographically known groups. Beginning from the same ethnographic observation, Bandelier (1881) and V. Mindeleff (1891) hoped to trace the developmental history of the clan through archeology. C. Mindeleff (1898) felt that matrilocal residence patterns would account for sites which were irregular in outline and arrangement.

A few attempts were made to explain, in causal terms, the variability seen in the archeological record. One example is an argument advanced by Hewett (1908), cited in Longacre (1970a), to account for differences between regularly and irregularly arranged sites. Hewett attributed these differences to the differential manner in which each kind of site had grown or expanded. He argued that regularly arranged sites resulted from situations in which entire social groups joined one another at a single episode, and whole blocks of rooms were added as unified, planned units. On the other hand, situations in which site expansion resulted from incremental population growth gave rise to irregular site plans as units were added singularly through time. Another example is seen in the work of C. Mindeleff (1900) who attempted to explain the temporal change from scattered small villages to large aggregated towns by proposing that raids by Athabascan nomads forced Puebloan peoples to aggregate for defensive purposes. This explanation of Puebloan aggregation

has persisted in the archeological literature in one form or another, untested, to the present day (e.g., see Gladwin 1957; McGregor 1965). Some Southwesternists (e.g., Hester 1962) argue that the Athabascans had not yet arrived in the Southwest by the time that a great deal of population aggregation had already occurred and, thus, the Athabascans cannot have been a causal factor.

For the period of 35 years from 1915 to 1950, which Taylor (1954:563) terms the "Time-space Revolution," the earlier concern with social organization was rejected as "useless speculation" (Longacre 1970a:4). According to Longacre (1970a:6), "There is virtually no concern on the part of archeologists with reconstructing Pueblo social organization during this period." Strict historicism became the rule of the day, and archeologists concentrated upon defining culture traits, establishing chronologies, and working out culture histories. One benefit of the "Time-space Revolution" is that it dispelled simplistic notions about Southwestern prehistory. During the previous period, the archeological record had been regarded as a straight-forward, homogeneous reflection of the early stages of Puebloan development, but the work accomplished from 1915 to 1950 revealed the truly complex nature of Southwestern prehistory.

Although archeologists of this period withdrew from the arena of reconstruction of prehistoric social organization, some ethnologists maintained interest in such questions. In reconstructing social organization, they generally argued from ethnography to prehistory, using the archeological record selectively when some particular pattern or sequence supported their pet position. In one ethnological study, Strong (1927) briefly speculated on the developmental history of clans in the Southwest. He felt that, prior to aggregation in large pueblos, the peoples of the Southwest had inhabited small, scattered villages and were organized by descent groups on the order of localized lineages. At a later time, when the once isolated villages began to aggregate, ". . . presumably due to concentration against invaders" (Strong 1927:53-54), these lineages began to merge, giving rise to clan organization.

The principal interest of a later study by Steward (1937) was explanation of Southwestern clan organization. He proposed that unilateral, localized, exagamous, land-owning lineages were present in the Southwest at least by Basketmaker III times. Population increase then began; and, according to Steward, one of three alternative situations resulted: (1) bands simply grew larger but occupied the

same territory; (2) bands became more numerous but each occupied less territory; or (3) multi-band villages began to form. Steward opted for the third alternative as the one which actually took place. He proposed that the primary cause for multi-band village formation was a need for defense against invaders, but a secondary causal role was assigned to the tendency for newly formed lineages in an expanding population to simply remain at the parent village rather than move to a new location, and this situation of forced co-residence resulted eventually, and inevitably, in clan organization. From the present-day perspective, it seems peculiar that these explanations of clan organization by Strong and Steward generated little or no interest among archeologists.

After 1950, Southwestern archeology experienced renewed interest in prehistoric social organization. An essay by Margin and Rinaldo (1950) is credited by Leone (1972) with having returned questions of social organization to a legitimate status in archeological research. In their essay, social organizational inferences were not based simply upon ethnographic analogy for, as Rock (1974) has observed, Martin and Rinaldo drew much of their interpretations from artifact distributions and habitation room floor areas. Their work also ran contrary to strict historicalist interests in that social organization was treated as a functionally integrated part of the more inclusive social system.

At about the same time as Martin and Rinaldo's work, Reed (1950) and Hawley (1950) also offered some descriptive reconstructions of prehistoric social organization, arrived at principally through ethnographic analogy. Probably the most significant methodological development to occur in terms of social organizational questions was Willey's (1953) introduction of settlement pattern studies, for such studies offer a methodological tool highly appropriate to questions of organization. Haury (1956) heralded the shift in emphasis from historical to functional questions made possible by a settlement pattern perspective in an article which offered his overview on the sociological meaning of temporal changes in settlement patterns in the Southwest. Wendorf (1956) compared settlement patterns for the Chaco Anasazi and the Tularosa Mogollon, emphasizing the sociological significance of differences and similarities. Bluhm (1960), after tracing Mogollon settlement patterns from about 200 B.C. to A.D. 1250, suggested the presence of multi-village organization in the Pine Lawn Valley near the end of this sequence and

called upon the mechanism of stimulus diffusion to explain changes in the character of Mogollon social organization through time.

Recent Trends

In the early 1960's, a number of concepts, foreign to previous archeological thinking, began to appear in the literature. These new ideas were combined by Caldwell (1966) under the rubric of the "new archeology." Though various problem areas have been recognized as pertinent to the new archeology (Bayard 1969; Kushner 1970), one stated objective is reconstruction and/or explanation of prehistoric social organization. It is usually proposed that social organization is to be seen in a systematic sense as one facet of human behavioral adaptation to changing circumstances (Binford 1962, 1965; Hill 1970a, 1970b; Longacre 1966). Much of the early writing in this new vein was theoretical and perhaps intentionally polemical, but by the late 1960's, some of the new ideas began to crystallize in the literature as concrete studies based on controlled archeological data.

On the descriptive side of the ledger, Longacre (1964a, 1968, 1970b) and Hill (1966, 1970a) devised and carried out procedures for drawing inferences about post-marital residence patterns from distributional patterns in archeological remains. An important, explicit part of their work and that of other "new" archeologists was the use of hypothetico-deductive (H-D) reasoning in establishing conclusions about prehistory. Both authors formulated hypotheses concerning residence patterns either prior to data collection or prior to data analysis, and data were then analyzed in terms of test implications drawn from these hypotheses. Their hypotheses were aimed at description or characterization of residence patterns for a given time period. Although each author also offered inductively derived conclusions concerning causal factors involved in the formation of the described residence patterns, neither arrived at these conclusions as a result of the hypotheses which were tested.

One product of the new archeologists' concern for prehistoric social organization is an entire volume of papers devoted to this subject by a number of authors (Longacre 1970c). An exemplary article from the volume by R. Gwinn Vivian (1970) approaches the study of social organization in Chaco Canyon from a descriptive point of view. He hypothesizes the presence of localized lineages and dual organization

in the canyon and then cites a number of test implications drawn from the hypotheses, which are to be tested in subsequent field work.

Turning to studies which seek to explain the archeological record in a causal sense, Longacre (1966) investigated the processes underlying the development of mechanisms of social integration in Mogollon society. He proposed that, prior to about A.D. 1000 or 1100, Mogollon society would characteristically segment into new villages when population maximums were reached in older villages; the practice resulted in the occurrence of numerous small pueblos, ranging up to 20 rooms. Beginning around A.D. 1000 or 1100, changing rainfall patterns necessitated adaptive changes in which people aggregated into larger villages. Descent groups which were previously separate were now together in large villages, and mechanisms for their integration began to arise. The appearance of kivas about this time is cited as an indicator of newly forming integrative mechanisms.

Although Longacre (1966) did not use the H-D approach, there is no reason why this approach cannot be used in conjunction with processual interests, and some students have done so. Griffin (1969) and Tuggle (1970) both formulated and tested hypotheses concerning causal factors involved in changing prehistoric social organizational patterns. For this purpose, they used archeological data gathered in and around the area of the Grasshopper site, not far from Vosberg Valley. Arguing that environmental fluctuations around A.D. 1100 forced Mogollon population aggregation, Griffin (1969) found a degree of support for the hypothesis that from this date onwards there followed an increasingly horticultural adaptation and a continuation of egalitarian society. He found cause to reject the alternative hypothesis that imposition of social ranking and the formation of a redistributive system might have resulted from this aggregation. Similarly, Tuggle (1970) tested and found some support for the hypothesis that an increasing reliance on agriculture engenders increasing interdependence between separate villages in social, ceremonial, and economic affairs.

Relying mainly upon archeological data from the Hay Hollow Valley in east-central Arizona, Plog (1974) addressed the extremely broad problem of the change from Basketmaker to Pueblo in the Anasazi area. Among other things he looked at changes in the structure of society which occurred in the transitionary period. His analysis

was specifically aimed at changes in society's integrative dimension. Plog (1974:157-160) concluded that the transition from Basketmaker to Pueblo was, in part, precipitated by the reorganizational requirements imposed by adoption of an intensive agricultural way of life and consequent population expansion.

Another study using data from the Hay Hollow Valley (Zubrow 1975) analyzed distributional patterns in population and settlement as a function of variation in the carrying capacity of different resource zones. Zubrow tested the following four hypotheses:

1. The development of population in marginal resource zones is a function of optimal zone population exploitation.

2. During periods of resource depletion, there will be a population aggregation of settlements.

3. During periods of resource depletion, there will be spatial aggregation of settlements.

4. During periods of resource depletion, the residential area of sites decreases (Zubrow 1975:51).

Despite the fact that Zubrow's "carrying capacity" figures were derived completely from naturally occurring food sources, ignoring the role of agriculture in its contribution to carrying capacity, he found that each of the four hypotheses was supported.

Comparing the work of Longacre and Hill to that of their students and that of Plog, one can see that the goals of recent processual studies concerned with prehistoric social organization differ from the goals of a descriptive approach in that recent goals are very much in keeping with the ecological approach outlined by Anderson (1973). Longacre and Hill were both interested in characterizing post-marital residence patterns in terms of anthropological concepts. Plog (1974:ix) has questioned the archeological worth of their approach: "I am equally convinced that efforts to understand prehistoric social organization are likely to go astray when archeologists begin to employ the familiar terms of the ethnographer--matrilineality, matrilocality, tribe, band, etc." Recent processual studies are concerned with social organization, but their main thrust is to assess changes in the general organizational structure

of prehistoric society as a result of man's interaction with his surroundings. The present study is closely allied to these recent processual studies in that it looks at changing co-residence patterns in relation to growing population and concomitant changes in subsistence and technology.

Terms and Concepts

It was noted above that archeologists have been aware of a temporal change from small, scattered settlements to large towns and villages from the earliest days of Southwestern archeology. This phenomenon has generally come to be known as aggregation (Haury 1962:128; Martin and Plog 1973:208). The usual use of the term "aggregation" in broad syntheses of Southwestern prehistory sometimes leaves the reader with the impression that aggregation took place as a planned and coordinated pan-Southwestern movement. One almost feels that, at some specific point in time, prehistoric peoples began to abandon their separate, scattered dwellings and to move into larger, aggregated, planned villages and, eventually, towns.

This impression is one of the undesirable by-products of the historicalists' inclination to classify archeological data by lengthy periods of time. When the data of hundreds of years of Southwestern prehistory are lumped under the label of the "Such and Such Period," characterized by a given set of traits, gross misrepresentation results. For example, Wormington (1951) defined a "Developmental-Pueblo Period" from A.D. 700 to 1100, which saw the formation of communal houses and towns. McGregor (1965) recorded this same general phenomena as a trait characteristic of the "Adjustment Period," from about A.D. 700 to 900. For Daifuku (1961) aggregation took place in the "Florescent" period, lasting from about A.D. 700 to 1300. The lengths of time involved in these periods are 400, 200, and 500 years, respectively, though presumably each of these authors is referring to the same phenomenon. Of course, they do not believe that at A.D. 699 population was dispersed and at A.D. 700 aggregation took place. Obviously, they intend to indicate the temporal span during which aggregation occurred, but we are left uninformed on the significant question of when and where the change to larger villages occurred within the periods. This is not to say that generalization by large blocks of time is objectionable per se, for it facilitates communication

between archeologists and conveys basic ideas to nonprofessionals. The problem is that it obscures the kind of detail which is indispensable for fine-scaled processual studies.

Reference to more specific archeological studies reveals that aggregation of Southwestern peoples occurred at very different times in different places. For example, Steward (1937) dated aggregation in the San Juan area to the Pueblo II period, A.D. 900 to 1100. Brew (1946) described what he called Pueblo "towns," some with hundreds of rooms, already in existence by A.D. 700 in the Alkli Ridge area. In Chaco Canyon, one finds both large towns and small villages present by A.D. 850 (Vivian 1970; Wendorf 1956). Survey of the Navajo Reservoir disclosed arranged, aggregated villages in the A.D. 950 to 1050 Arboles phase (Eddy 1966). "Aggregation on a large scale" is said not to have begun in Kayenta country until the late date of A.D. 1150 (Martin and Plog 1973:129). In the Mogollon area, Martin and Rinaldo (1950) noted the appearance of contiguous roomed hamlets in the Reserve phase beginning around A.D. 1000, while Danson (1957), who surveyed Mogollon sites further east and south of those referred to by Martin and Rinaldo, stated that arranged, pueblo-like units were widespread, if not typical, during the A.D. 900 to 1100 period. Examples could be multiplied, but the above citations are sufficient to establish the point that population aggregation throughout the Southwest was not a singular event in time.

Besides temporal variation, there is also spatial variability in the phenomena which archeologists lump under the term aggregation. Some early studies, such as that by Roberts (1939), equated aggregation with the change from pit house to surface type architecture; Roberts called this kind of change the formation of unit-type dwellings. Above ground jacal structures, grouped and arranged in crescentic shapes, were present in the Mesa Verde area after A.D. 700 (Martin and Plog 1973). Pueblo towns of hundreds of rooms identified by Brew (1946) at about the same date differed from these jacal units. In Chaco Canyon, large towns and small villages occupied both sides of the canyon contemporaneously (Vivian 1970), while in the Kayenta area, Martin and Plog (1973) have noted simultaneous occupancy of aggregated surface dwellings and pit houses clear up to the time the area was abandoned. Thus, one also finds a degree of spatial variability in the character of aggregated sites.

Given that a range of temporal and spatial variability is evident in the movement to larger towns and villages, considerable diversity has been combined under the single rubric of aggregation by those who use the term without definition. Moreover, the term "aggregate" can be and is used as either a noun or a verb, both of which can be employed with different levels of meaning, allowing for possible further confusion. The verb "to aggregate" could be used in describing a situation in which more and more people come to be concentrated, through time, at individual sites (e.g., see Longacre 1968:93). At another level, aggregation can refer to situations in which sites themselves come to be located in closer proximity through time (e.g., see Zubrow 1975:94-95). Both situations can be referred to as aggregation, but one can reasonably speculate that related sociological changes in the two situations would be quite different.

The noun "aggregate" has none of the temporal connotations of the verb but refers simply to a group of things. Different levels of reference for the noun can be found in the volume, The Distribution of Prehistoric Population Aggregates (Gumerman 1971), wherein the scale of research has determined the unit which is to be considered an aggregate of population. This is exemplified through the study of population distribution in an entire transition zone (Gumerman and Johnson 1971) in comparison to the study limited to Long House Valley (Lindsay and Dean 1971). Accordingly, if one takes the entire Southwest as a research universe, then the total population along the Gila and Salt Rivers, or that along the Little Colorado River, or that in the central mountains of New Mexico and Arizona, might each be treated as single population aggregates. But if the universe is scaled down, the population of a single valley might also be called a population aggregate. With even further scaling down, a single, large site might be said to represent a population aggregate. A population aggregate can thus be used in reference to a number of things, while an aggregating population could refer to large scale, regional phenomena or small scale, site-specific phenomena.

In order to avoid terminological confusion, the changes under study in Vosberg Valley are referred to as co-residential changes rather than as aggregation. Co-residence, in this case, simply refers to people who live in the same place. Use of this term accentuates the demographic aspect of changes in which dwellings within a given site are located progressively closer and closer together.

Once it has been recognized that co-residential change in the Southwest was not uniform in time or space, it would seem to follow that one should not expect uniform causal factors to have been operative in all such cases. However, Martin and Plog (1973), in their chapter, "The Problem Regarding the Appearance of Towns," give the impression that early cases of the formation of aggregated villages uniformly represent an initial step in the continuing process which eventually culminated in the large towns known to have existed just prior to Spanish contact. That is, these authors treat early, small, aggregated villages and late, large villages and towns as qualitatively similar and regard observable differences as merely quantitative.

I submit that the phenomena now lumped under the rubric of aggregation in the literature of Southwestern archeology entails sufficient variability that it should be broken down into at least two types, from a sociological standpoint if for no other reason. From an explanatory perspective, it also seems probable that different processes may be involved. Initially, at a relatively early date in Southwest prehistory, there was aggregation or co-residential change of the type Roberts (1939) referred to as the formation of unit-type dwellings. The important aspect of this type of co-residential change is that people, previously inhabiting scattered or semi-isolated dwellings, came together in contiguous domiciliary units.

Beginning around A. D. 1000, the formation of unit-type dwellings began to occur in the northwestern part of the Mogollon region; that is, clusters of previously semi-isolated dwellings came to be replaced by villages of contiguous domiciliary units (Longacre 1964b; Martin and Rinaldo 1950). But, beginning perhaps around A. D. 1100 and continuing for the next few hundred years, co-residential changes of a different character occurred in the same area. Populations already existing as small, aggregated village units began to come together as cohesive groups into larger, common villages (Griffin 1969; Hill 1970a; Leone 1968; Longacre 1970b; Tuggle 1970). The principal difference is that in the initial case of the formation of unit-type dwellings, the component parts were individual habitation units; but, in the latter type of co-residential change, the component parts in the formation of large, aggregated villages were smaller village units, that is, relatively large numbers of people existing in a condition of social togetherness

but still inhabiting separate dwellings. According to Hill (1970a) and Longacre (1966), these units, which previously existed as separate, small, aggregated villages, maintained much of their social integrity even after coming together in large villages. Because of differences in the two types of co-residential change, the latter should be recognized as sociologically distinct from the kind discussed in the previous paragraph.

The idea of different types of co-residential change has been developed in order to characterize appropriately the changes which took place in Vosberg Valley and which are the subject of inquiry in this study. Co-residential change in Vosberg Valley between A.D. 1050 and 1250 is regarded as an example of the formation of unit-type dwellings from a previous condition of scattered dwellings.

I have chosen to characterize the above change as a change in patterns of co-residence, and it is thus necessary at this point to state briefly what is meant by co-residence and to discuss how one determines patterns of co-residence. Recognition of co-residence patterns depends upon initial recognition of residence units, the latter of which are defined by Hill (1970b:15) as ". . . localized aggregations of people living together for various purposes (for example, nuclear family households, extended family households, localized lineage segments, and so on)." Additionally, this study defines the constituent smaller parts of residence units as residence elements. The identification of individual residence elements is based upon our ability to archeologically recognize functionally distinct but probably equivalent component parts of a given residence unit. Observable variation in the number and arrangement of residence elements within residence units can be identified as a difference in patterns of co-residence. In the case of Vosberg Valley, it is postulated that changing co-residence patterns occurred with the passage of time.

In order to inject sociological implications into this study, it is desirable to identify each of the sites in Vosberg Valley, scattered or aggregated, as the physical locus of a past socio-economic group. Rohn (1965:65) has suggested that archeologists use this term because the cohesion of socio-economic groups probably rests upon sociological factors, while, archeologically, we recognize such groups on the basis of cooperative economic behavior, that is, the sharing of space, facilities, and resources for the satisfaction of individual needs.

Given the manners in which Hill (1970b) and Rohn (1965) have defined the above terms, it is possible to combine the idea of the socio-economic group with that of the residence unit and provisionally identify each spatially distinct cluster of architectural units in Vosberg Valley as a residence unit inhabited by a separate socio-economic group. Both entities as defined are recognizable on the basis of physical remains though not directly through examination of surface manifestations alone. A change in co-residence patterns thus represents a change in the numerical constituency of the sub-units of socio-economic groups.

It will be argued below, and supporting evidence will be cited, that the groups which occupied individual architectural structures at various sites in Vosberg Valley were probably nuclear family groups and that each site functioned as a locus at which various numbers of nuclear family groups lived together and carried out a variety of domestic activities, such as preparation and consumption of food and manufacture of tools in addition to practicing ritual activities. In the final analysis, the argument being presented is that changes in co-residence patterns in Vosberg Valley involved an increase through time in the number of nuclear families inhabiting any given site.

It must be emphasized that the explanation offered below for changes in co-residence patterns is not intended to apply to any prehistorically recognized social units. My argument of occupancy of structures by nuclear family groups is based upon archeological criteria. It may be that the prehistoric people of Vosberg Valley conceived of each site as some kind of individual social unit or of several sites as such a unit, but this is irrelevant from the perspective of changing patterns of co-residence as defined above. It was surmised in the introductory remarks that changes in patterns of co-residence probably play a role in initiating changes in some non-spatial aspects of social organization, but a discussion of these other changes is beyond the scope of this study. My intended purpose is explication of causal factors underlying changing co-residence rather than social readjustments which may stem from such changes.

CHAPTER III

ARCHEOLOGICAL BACKGROUND

It is common practice in archeological monographs when discussing the location of a research area to include a description of its environmental setting. But often this proves to be a meaningless exercise in that little or no attempt is made to relate the described environmental factors to the archeological discussion. Given the assumption stated in the introductory remarks that environmental setting and features of habitat play an important role in determining human behavior, environmental factors are dealt with in detail as part of data analyses in Chapter V.

Location of Vosberg and Regional Physiography

The Vosberg locality is in Gila County, Arizona, in the central to east-central part of the State. The name "Vosberg" was given to the locality by A. E. Dittert, Jr. (n.d.) after the owners of the now-abandoned Flying-V ranch house located at the southern end of the small valley which comprises the locality. This valley is about 10 kilometers southeast of Young, Arizona, and less than 30 kilometers south of State Highway 260 from Payson to Heber (figure 1). In the GLO system, the valley is located partially or completely in sections 4-9, 16-18, and 20 of T. 8 N., R. 15 E.

Geologists generally divide the State of Arizona into two major physiographic provinces (Wilson and Moore 1959). Much of the northern and eastern part of the State has been designated the Colorado Plateau province, while southern and western Arizona fall within the Basin and Range province. Separating these two provinces and running diagonally through the central portion of the State is a Transition Zone in which Vosberg Valley is centrally located. The northern edge of the Transition Zone coincides with the Mogollon Rim, a prominent escarpment reaching elevations in excess of 2300 meters in the general area just north of Vosberg. Moving south from the Mogollon Rim, elevation decreases while traversing the rugged, mountainous Transition Zone. Numerous small waterways have carved the area into a series of discreet and semi-discreet valleys, canyons, and gorges of which Vosberg

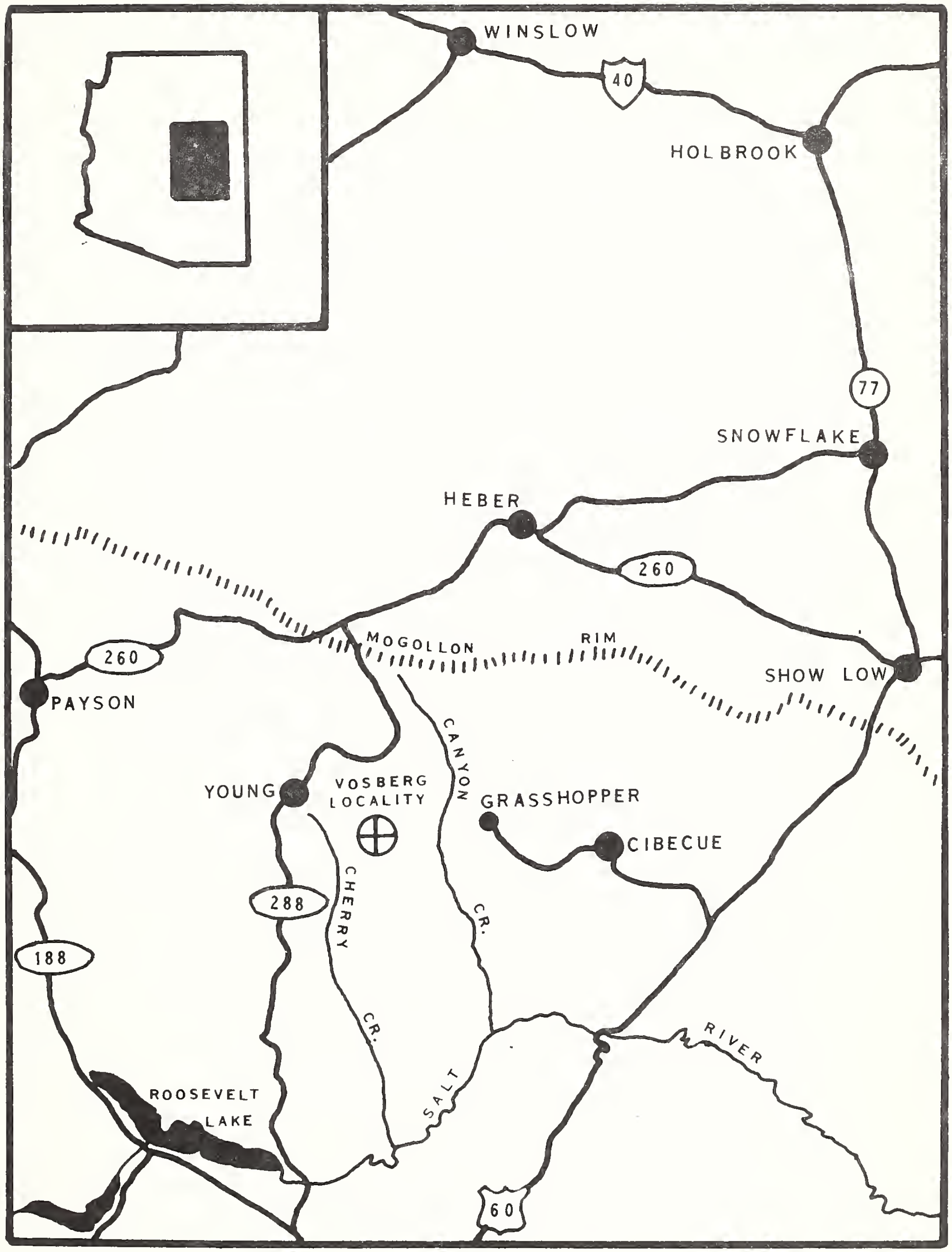


Figure 1. Location of Vosberg Valley within the State.

Valley is an example. The valley forms the head-water basin for Walnut Creek which flows out of the southwest corner of the basin and joins Cherry Creek a few kilometers further to the southwest. Cherry Creek, like all other creeks below the Mogollon Rim in this area, flows south and drains into the Salt River.

Archeology in Vosberg Valley

The archeological record in Vosberg Valley was the subject of investigations by Arizona State University field school sessions over a period of four consecutive seasons. In 1967, field work was directed by D. H. Morris; the investigations of 1978 through 1970 were directed by A. E. Dittert, Jr.; and in 1970 Dittert was assisted by J. Schoenwetter. During the four seasons of field work, students excavated at a number of archeological sites. Excavated habitation sites include those numbered AZ P:13:1, P:13:7, P:13:10, P:13:13, P:13:17, P:13:19, P:13:26, and P:13:29. (Note: These and all other site numbers referenced are Arizona State University field numbers.) In addition, J. B. Rodgers undertook investigation of a number of agricultural elements at various locations in the valley. He excavated and/or mapped agricultural sites or units at AZ P:13:10 Unit II, P:13:28, P:13:29 Unit II, P:13:33 Unit II, P:13:39 Unit II, P:13:43, P:13:47, P:13:57 Unit II, P:13:59, and P:13:72. In each field season students assisted in surface surveys which ultimately resulted in the location, collection, and description of 62 archeological sites within the valley and several more outside the valley.

Field work accomplished in 1967 served as the basis for two reports by Morris (1969, 1970) which were primarily concerned with excavations at the pit house site of Walnut Creek Village (AZ P:13:1). The work of all four seasons was briefly summarized by Dittert (n.d.), while Rodgers (1970) described and classified the components of the agricultural systems which he investigated. In addition, students at Arizona State University have conducted analyses of restricted portions of the ceramic data from Vosberg Valley in connection with course work. Portions of the survey data were used by Chenhall (1972, 1975) for purposes of a methodological inquiry concerning the validity of random sampling as an archeological survey technique. Trade contacts at Vosberg, as evidenced in various categories of materials and artifacts, served as the topic for a thesis (Harris 1974). Another student is currently involved in

analysis of floor material from a room at AZ P:13:29. The bulk of the archeological data resulting from field work in 1968 through 1970 had not been analyzed in any detailed or comprehensive manner prior to this study.

Once the decision was made to undertake analysis of a portion of the Vosberg material, a specific, testable hypothesis was formulated; but it was found that further field work would be necessary to test the hypothesis. During this field work, conducted on an intermittent basis in the spring and summer of 1974, an attempt was made to relocate and reevaluate all previously recorded sites. Additionally, further surface collections were made on sites for which existing materials were considered quantitatively inadequate. All but two of the originally recorded sites were relocated. The 1974 field work was initiated with the impression that at least 90 percent of the sites in the valley had been recorded. However, in the process of searching for the originally recorded sites, previously unrecorded sites were continually encountered; and it soon became apparent that further controlled survey would be necessary for purposes of the problem orientation of this dissertation. Due to considerations of time and personnel, an intensive resurvey of the entire valley seemed out of the question. Therefore, two survey transects, roughly perpendicular to the long axis of the valley, were established and surveyed intensively. New sites located within the transects, plus those newly found while searching for the original sites, plus the original sites, brought the total number of known sites in the valley to 87. Not all of these sites are relevant to the present research. Those which are relevant, as well as the locations and descriptions of the two transects, are discussed in the section on data analysis. Apart from the site survey, 120 soil samples were taken at systematically chosen locations during the course of the 1974 field work. Soil sample analysis is also discussed under data analysis.

The Problem: Initial Formulation

A chronology for Vosberg Valley was established by Chenhall (1972) when he used data from the valley to examine the problem of random sampling in archeological survey. He emphasized ceramic materials from a number of excavated features for this purpose, but restricted his analysis to those sherds demonstrably in association with room

floors. On the basis of "Ceramic Groups" and historical data, Chenhall (1972:52-55) identified ten time periods significant in Vosberg prehistory. The periods and a brief definition of each are given in table 1. This study restricts its concern only to data of the time period from A. D. 1050 to 1250. According to Chenhall's analysis, brief periods of nonoccupation preceded and followed this period, thereby allowing convenient and fairly reliable segregation of archeological materials relevant to the problem under investigation. Chenhall's analysis of survey data, Dittert's assessment of excavated material, and Rodger's analysis of Vosberg Valley's agricultural system have all played a part in formulation of a specific problem.

Ceramically, the A. D. 1050 to 1250 period is characterized by Ceramic Group IV (Chenhall 1972), a group which includes both plain and decorated wares. Assuming accuracy of ceramic type identifications, a few of the painted, decorated sherds found in features dated by Chenhall to the A. D. 1050 to 1250 period seem to have been made prior to initiation of the horizon. These early sherds were identified as Kiatuthlana Black-on-white, a type to which Breternitz (1966) assigns inclusive dates of A. D. 825 or 850 to 910. However, all other identified, painted, decorated Group IV types from floor features have inclusive dates which range into the A. D. 1050 to 1250 period. According to Chenhall, these other painted, decorated types include Red Mesa Black-on-white, Black Mesa Black-on-white, Sosi Black-on-white, Reserve Black-on-white, Snowflake Black-on-white, Gallup Black-on-white, Puerco Black-on-white, and Tularosa Black-on-white. Sacaton Red-on-buff, as well as Wingate and Pinedale Black-on-reds, were also identified. Polychromes of Ceramic Group IV include Pinto, Gila, and Pinedale types.

Painted, decorated ceramics from all provenience units at Vosberg, both surface and excavated, always appear in low frequencies relative to plain and corrugated ceramics. Given this data, plus the fact that all of these painted, decorated types are known to have nonlocal origin, it is concluded that no painted, decorated pottery was actually made in Vosberg Valley. Apparently all such sherds represent trade items from other areas.

Indigenous Vosberg ceramics are both plain and corrugated wares. Vosberg's plain wares have been divided by Dittert (n. d.) into an early Flying-V Brown and a later Vosberg Brown, the latter of

Table 1

VOSBERG CHRONOLOGY

Period	Description
Prior to A.D. 700	Lack of ceramics and definable structures. Sparse evidence for early hunting camps.
A.D. 700-800	Ceramic Group I in association with pit houses.
A.D. 750-900	Ceramic Group II in association with pit houses.
A.D. 900-1000	Ceramic Group III in association with pit houses.
A.D. 1000-1050	Apparent break in ceramic pattern, interpreted as period of nonoccupation.
A.D. 1050-1250	Ceramic Group IV in association with boulder-cobble outlined, jacal structures.
A.D. 1250-1300	Apparent break in ceramic pattern, interpreted as period of nonoccupation.
A.D. 1300-1400	Ceramic Group V in association with masonry pueblo.
A.D. 1400-1850	Apparent abandonment of the locality.
A.D. 1850-present	Anglo occupation.

After Chenhall 1972:52-55.

which replaces the former through time. However, the distinction between the two types is rather general and difficult, if not impossible, to make on a majority of the individual sherds. Both are plain brown types, made with local clays and tempered with local diabase which underlies the valley floor. Vosberg Brown is a thicker, more crudely made pottery than Flying-V Brown, and its temper is less finely crushed. In addition, Flying-V Brown is more often polished than Vosberg Brown. Dittert feels that Flying-V Brown pertains to the period of pit house architecture in the valley, and my own work with Vosberg ceramics supports this idea. Most of the plain ware of the A.D. 1050 to 1250 period, with the exception of a few traded types, is identifiable as Vosberg Brown.

One diagnostic ceramic for the valley in this time period is a locally made corrugated type designated Vosberg Corrugated (Doerschlag n.d.). The name is not completely descriptive in that it is actually an indented, corrugated pottery. The brown colored paste of this pottery is the same as that of the locally made plain wares, and it also has crushed diabase temper. Sometimes the exterior surfaces were simply corrugated and indented; but, in most examples, corrugations were smeared to various degrees (plates XXVIII through XXXI). During the A.D. 1050 to 1250 period, Vosberg Corrugated begins to increase in frequency as Vosberg Brown decreases and, near the end of the period, replacement is virtually complete.

A second diagnostic ceramic is Salado Red; Vosberg Variety (Rodgers and Weaver n.d.). This is also an indented, corrugated type on which the corrugations were smeared to various degrees (plates XXXII through XXXV). It is more finely made than Vosberg Corrugated; it is almost always thinner than Vosberg Corrugated; the outside is coated with a maroon wash; and the interior is often smudged and sometimes polished. Salado Red; Vosberg Variety, like Vosberg Corrugated, increases in frequency through the time period. Vosberg Brown, Vosberg Corrugated, and Salado Red; Vosberg Variety, make up the overwhelming bulk of ceramics during the A.D. 1050 to 1250 period.

Prior to A.D. 1050, architecture at Vosberg consisted of pit houses (Chenhall 1972; Morris 1970), but around A.D. 1050 pit houses were replaced by structures best described as houses in pits. In the latter type of construction, a large depression was excavated down to, and often into, the diabase substrate. The perimeter of the depression was lined with unshaped boulders and cobbles varying

from one to three or four courses in height, depending upon the depth to which the depression had been excavated. Where these structures were built on hill slopes, which was often the case, the upslope wall would be excavated to the same level as the downslope wall and would require more courses of stone. Posts were placed inside the boulder-cobble perimeters, and rectangular superstructures, apparently of jacal, were then constructed within the limits provided by the stone lining. These dwellings were relatively large, generally having dimensions of 4 x 5 meters.

Once the superstructures have collapsed and sufficient time has elapsed, such structures show up, surficially, as rectangular outlines of boulders and cobbles, often with the downslope wall apparently missing or difficult to discern. At some sites, the outlines are clear and unmistakable; at other sites, scattered boulders and cobbles may be merely suggestive of the former presence of such structures; but at most sites the clarity of room outlines falls between the above two extremes. Considering all of the sites dated between A.D. 1050 and 1250, most have surface indications of boulder-cobble outlined jacal structures, though some produced only sherds and lithics with no surface indications of structures. In size, the former range from single room sites to sites of 25 and more rooms. But, due to differential preservation, room counts are more precisely described as room estimates.

Using size as the criterion, Chenhall (1972:73) separated sites having boulder-cobble outlined structures into two groups, postulating that differences between the two types were functional. Sites with more than five rooms were classified as habitation centers at which there was year-round residence, and sites with five or less rooms were designated field houses. According to Chenhall, field houses were temporarily occupied for purposes of tending agricultural plots located away from habitation centers. Thus, all of the sites in Vosberg Valley distinguished by boulder-cobble outlined structures were included by Chenhall in the A.D. 1050 to 1250 period, but such sites were grouped into two less inclusive categories on the basis of assumed functional differences.

Dittert (personal communication) has suggested an interpretation which differs from that offered by Chenhall. He feels that differences noted in the size of sites with structures present are due to change through time rather than differences in function. In his

view, the settlement pattern around A.D. 1050 was one in which small sites of one, two, or three rooms were scattered at various locations in the valley. By the date of A.D. 1250, however, he feels that the intracommunity pattern had changed to one in which habitation units were arranged in relatively large groups of aligned, contiguous dwellings, sometimes facing each other across an open, plaza-like area. In addition to increasing size, Dittert has also suggested that sites came to be located further up the hill slopes through time.

As a starting point, this study is based on the proposition that Dittert's assessment of the situation is essentially correct. The postulated change in settlement patterns from a scattered to an aggregated condition is identifiable as a change in patterns of co-residence, and the problem-focus of this study is explanation of this change. As mentioned in the introductory remarks, it is my position that relevant causal factors should be sought in an interactive network involving human beings and their organic and inorganic surroundings, i.e., environment sensu lato. The data of survey, excavation, and that pertaining to bio-physical environmental variables can each be brought to bear on this problem; but, in addition, some of the site types recorded on the valley allow consideration of land utilization practices as another variable in this causal formula.

Besides sites with boulder-cobble outlined structures and a number of sherd and lithic scatters with no associated architecture, surface survey revealed other sites consisting of soil and water control devices, i.e., agricultural systems. Some agricultural systems are found directly associated with habitation sites, but others are spatially separate. The isolated agricultural sites had little or no associated ceramic material and are thus difficult to date. Where agricultural elements are directly associated with habitation sites, a date can be inferred from that of the site. But where agricultural sites are spatially isolated, the only recourse is to use the date of the habitation site which is either closest or which is most readily accessible to the agricultural elements.

Despite dating difficulties, Rodgers (1970) was able to establish a convincing chronology for agricultural systems and a typology of agricultural elements in Vosberg Valley. These systems are composed of various combinations of check dams, crescentic walls, grid borders, ridge walls, brush structures, and channeling walls. Rodgers identified four types of systems, lettered A, B,

C, and C(D), of which the last three are thought to relate to the A. D. 1050 to 1250 time period; the first predates this period. Agricultural system type B catches surface runoff on colluvial slopes and directs it, via natural drainages, to agricultural plots situated further downslope. System type C, which takes flood water out of natural drainages and directs it toward agricultural plots on colluvial ridges at approximately the same contour, is more complicated and incorporates more elements than type B. Agricultural system type C(D) is a variant of C wherein runoff is caught on colluvial slopes and directed toward plots on the same slopes. Individual agricultural plots within these systems are composed of elements such as grid borders which catch and accumulate soil on their upslope sides. Thus, according to Rodgers' analysis, the prehistoric inhabitants in the valley engaged in special measures to secure and retain both soil and water on the slopes for purposes of agriculture. Recognition of these agricultural systems offers invaluable insight into prehistoric land utilization practices, a facet of prehistoric human behavior often lost to archeology. These land utilization practices are given primary consideration in formulation of an explanatory hypothesis for changing co-residence patterns in Vosberg Valley.

It should be pointed out that the bulk of field work which provides data for this analysis was not conducted from the perspective of the present problem orientation. The analytical procedure chosen for investigation of the problem involves establishment of a hypothesis to be tested through archeological data analysis. Ideally, selection of sites for excavation and of appropriate data recovery techniques should be made on the basis of problem orientation, but this has not been possible in the present case. If explanation of changing co-residence patterns had been the initial focus of research, different sites would have been selected for excavation and some alteration of data recovery techniques probably would have resulted. These limitations cannot be ignored, but they need not severely constrain testing the hypothesis.

Archeology in Nearby Areas

Chenhall (1972:29-33) has briefly summarized the results of archeological studies in areas near Vosberg Valley. At the time of his summary, not many such studies existed, and this is still the case at present. Chenhall's work should be consulted for a more complete list of references, but some of the most relevant work is discussed below.

About 40 kilometers west of Vosberg Valley, Kelly (1969) conducted surface survey around Payson, Arizona, in an area which, like Vosberg, is located in the Transition Zone below the Mogollon Rim. Kelly recorded 49 archeological sites, 44 of which he dated between A.D. 1000 and 1200, establishing this as the period of major occupation in the area. This period roughly equates with the A.D. 1050 to 1250 period of major occupation in Vosberg Valley. Due to Kelly's sketchy description and illustration of architecture in the Payson area, comparison with that at Vosberg is not possible. However, personal inspection of the ceramic material from a dozen of Kelly's sites disclosed a preponderance of plain red-brown ware which Kelly identified as Tonto Red. Corrugated ceramics, which are ubiquitous in Vosberg Valley during this period, are virtually absent from the Payson area collections. Ceramically, at least, there seems to be little connection between Vosberg and temporally equivalent manifestations close by to the west; recent work by Glen Hanson (personal communication) in 1975 in the Payson area supports this suggestion.

Survey data not available to Chenhall was gathered by Wells (1971) in the area at the confluence of Cherry Creek and the Salt River, about 40 kilometers south of Vosberg Valley. Wells established a chronology based on Ceramic Groups, numbered in chronological sequence from I to VIII. Temporally, Groups III, IV, and V span the period from A.D. 1100 to 1250 and are the only ones requiring consideration here. The predominant ceramic type of Group III, dated A.D. 1100 to 1150, is Tonto Red. Painted, decorated types include Snowflake Black-on-white, Reserve Black-on-white, Tularosa Black-on-white, and Roosevelt Black-on-white. The only architecture which compares favorably with boulder-cobble outlined rooms in Vosberg Valley is that associated with ceramics of Group III. Two patterns of room number and arrangement were noted on lower Cherry Creek for this time period. Most sites had

one to five scattered rooms, but some were villages of 15 to 30 rooms, aggregated into dual units separated by a space of about 50 meters. Such a pattern is equivalent to site arrangement in Vosberg Valley near the end of the A. D. 1050 to 1250 period. The locations of comparable sites in the two areas also compare favorably; lower Cherry Creek sites with boulder-cobble outlined structures are situated, like those at Vosberg, well up the ridges which slope toward the Creek.

According to Wells (1971), settlement patterns changed abruptly after A. D. 1150. Architecturally, room walls came to be completely of masonry, replacing jacal type walls of the previous period. Internal site arrangement became more diversified, and many sites, now located predominantly at the edge of the first bench, were enclosed by low walls. No sites of this period were found on the ridges occupied by sites of the previous period. However, it is during this period that indigenously made brown, corrugated wares and Salado Red make their appearance on lower Cherry Creek, though Tonto Red remained the dominant utility ware throughout all periods. Painted, decorated types of the previous period continued with the addition of McDonald Corrugated to Ceramic Group IV, dated A. D. 1150 to 1200.

Ceramic Group V, dated A. D. 1200 to 1250, is characterized by the addition of Pinto Polychrome, Pink Pinto Polychrome, St. Johns Polychrome, and Pinedale Black-on-red. Continuity with the preceding period is seen in architecture and settlement patterns with the exception of the addition of large (6 meters in diameter) circular structures at two sites.

In summary, a general comparison of Vosberg Valley and lower Cherry Creek indicates some ceramic similarities and some differences for most of the time periods considered in each area. Only from A. D. 1100 to 1150 does architecture, as well as settlement size, arrangement, and location, compare favorably between the two areas. After A. D. 1150, significant changes occurred along lower Cherry Creek, but the general pattern initiated in Vosberg Valley around A.D. 1050 continued until about A. D. 1250.

Roughly 24 kilometers to the east of Vosberg, Tuggle (1970) conducted surface survey in the area immediately surrounding the Grasshopper site. He developed a chronological framework for

sites in the area based on ceramic types present (Tuggle 1970:25-33). Periods thus established were labeled Late Mogollon 1, 2, and 3, but only Late Mogollon 2 is relevant for comparison to Vosberg since it has been dated from A.D. 1100 to 1250. Sites of this time period produced ceramic types identified as Snowflake Black-on-white, McDonald Painted Corrugated, and early White Mountain Redwares such as Wingate Polychrome, St. Johns Polychrome, and Show Low Black-on-red. However, most sherds were of an unpainted, indented, corrugated brown ware. Ceramics were associated with masonry architecture at 38 sites. This "masonry architecture" and internal site arrangement were not fully described by Tuggle, but on an impressionistic level, they seem to compare favorably with structures at Vosberg. Tentatively, the conclusion that ceramics and architecture at Vosberg and around Grasshopper are comparable seems warranted, but this is not surprising since the two areas are spatially very close together.

In addition to the work of Kelly and Tuggle, Chenhall considered work done by Martin and others (e.g., 1962, 1964) in the upper Little Colorado River area. From these various sources, Chenhall (1972:30) concluded, "The ceramics and architectural styles found in the Vosberg District seem to indicate that the major influences in the area were from the north and the east." Wells' (1971) work indicates that there were also behavioral ties to the south, but the nature of these links remains obscure at present.

CHAPTER IV

THEORETICAL ORIENTATION AND HYPOTHESES

Human Ecology

The theoretical approach employed in the investigation of co-residential change in Vosberg Valley is explicitly behavioral and focuses attention upon patterns of human behavior, the ways in which such patterns vary through space and time, and the causes of change in such patterns. In order to explain human behavior, I believe that it is both necessary and logical to posit human organisms themselves as the relevant unit of analysis and study. I recognize that there is a long-standing tradition among numerous anthropologists and archeologists that the raison d'etre of anthropology is the study of culture qua culture. Those holding such a superorganic or culturological position (e.g., Kroeber 1917; White 1949, 1959) also hold that human behavior is caused or determined by culture and that we must, therefore, study culture itself as a means of explaining human behavior. Human ecological research as conceived in this study expressly questions the acceptability of studies predicted upon the a priori assertion that human behavior is determined by culture because such studies tend to ignore or minimize the role of human organisms. I feel that the culturological position incorporates a fallacy of misplaced concreteness, for I identify "culture" as an abstraction, a social science construct, used by anthropologists to characterize man's mode of life and distinguish it from that of other organisms. I hold that abstractions, as abstractions, cannot be the determinants of objective phenomena such as human behavior. Causality should be sought in the phenomenal world.

The approach taken in the present inquiry is ecological, somewhat in the sense of Vayda and Rappaport (1968) and Watson and Watson (1969). It seeks to elucidate the determinants of human behavior patterns through an investigation of relationships which obtain between socially organized human beings and their surroundings, the latter being defined by substances, forces, and conditions external to human organisms. This includes not only the biophysical environmental surroundings but also other socially organized human beings and the myriad array of culturally created paraphernalia which surrounds the individual in day-to-day existence.

Use of a human ecological approach should serve to bring anthropological and archeological studies closer to the broader field of general biological ecology. I find that the goals of the latter field are quite compatible with anthropological studies which seek to establish the determinants of human behavior by reference to events in the phenomenological realm. According to the biological ecologist Billings (1970:1), "Ecology is the attempt to understand the relationships of plants and animals to their environment--where they live, how they live there, and, hopefully, why they live there." Such attempts are undertaken by biological ecologists in a systemic framework which, according to Billings (1970:2), ". . . consists of a central biological component of one or more organisms and the environment with which the organisms interact and from which they receive energy." (Emphasis mine.) Understandably, for the biological ecologist, this central biological component always consists of energy-consuming, reproducing, responsive, living organisms. It is poor scientific procedure and unsound reasoning for anthropologists to take an abstract concept like culture and make it the focus of analysis and the central systemic component as is done, or implied, in some cultural ecological research (e.g., Struever 1968). In this sense, cultural ecology cannot legitimately be operationalized. Culture, as an abstraction, does not interact with the environment and does not receive energy from the environment, but human organisms do interact with and receive energy from their environment. The latter are capable of responding to forces, substances, and conditions around them and are, therefore, the appropriate unit of study within an ecological framework. Ecological studies may focus on individuals, populations, species, or groups of species depending on one's problem orientation. The present study treats the human population of Vosberg Valley as the central biological component.

Biological ecologists generally recognize two major subdivisions of ecology: autecology and synecology. According to Odum (1971:6),

> Autecology deals with the study of the individual organism or an individual species. Life histories and behavior as a means of adaptation to the environment are usually emphasized. Synecology deals with the study of groups of organisms which are associated together as a unit . . . . In the former instance attention is sharply focused on a particular organism with the purpose of seeing how it fits into the

general ecological picture, much as one might focus attention on a particular object in a painting. In the latter instance, the picture as a whole is considered, much as one might study the composition of the painting.

Since the present study focuses attention on human organisms as the central systemic, biological component, it is regarded as one of human autecology.

The human ecological approach employed treats the cause(s) of human behavior as an unknown factor to be determined through investigative analysis, rather than by assertion or fiat. To this end, a hypothesis has been formulated in which causality for changing co-residence patterns in Vosberg Valley is sought in an interactive network involving Vosberg's prehistoric human inhabitants, their population numbers, their land utilization practices, and the specific environmental configuration present in this small, mountain valley. Analysis of the archeological data is designed to fulfill a primary goal of verifying or refuting test implications drawn from the hypothesis. The higher goal of human ecology, and of this study, is the investigation of relationships between humans and their environment, _sensu lato,_ with the ultimate aim of explaining spatial and temporal variability in patterns of human behavior.

Hypothetico-Deductive Explanation

In the introductory remarks, there was a brief allusion to the "history vs. process" debate. In addressing himself to this issue, Binford (1968) interposed questions involving the nature of explanation itself. For uncertain reasons, the history vs. process debate quickly dropped by the wayside as the question of the nature of explanation developed into a veritable methodological soccer ball which is still being kicked around (see Fritz and Plog 1970; Hill 1968, Morgan 1973, 1974; Tuggle, Townsend, and Riley 1972; Watson, LeBlanc, and Redman 1971, 1974). A principal source of misunderstanding is rooted in the failure of some of the disputants to distinguish between the hypothetico-deductive approach (H-D method) and the deductive-nomological approach (D-N method). Fritz and Plog (1970), following the philosophers Hempel and Oppenheim (1948) and apparently stimulated by Binford's article (1968), took the position that to explain anything in a scientific sense one must demonstrate that it qualifies as a specific instance of some general or covering law. Their article

was soon countered by Tuggle, Townsend, and Riley (1972:4) who aptly pointed out that simple deductive reasoning need not be equated with D-N explanation and that, "A deductive argument does not have to begin with a law but needs only a major premise." This same point was made by Levin (1973) who commented additionally that hypothetico-deductive reasoning is not an alternative approach for archeologists, as Fritz and Plog proposed, but is something that all scientists do all of the time.

Shortly after Fritz and Plog's article, Watson, LeBlanc, and Redman (1971), also following Hempel and Oppenheim (1948), produced a book-length discussion on the nature of archeological explanation. Like Fritz and Plog, they took the position that scientific explanation is only accomplished by subsumption of a specific case under a general law, known to philosophers of science as the "gen requirement." Watson, LeBlanc, and Redman cited the work of Longacre (1970b) at Carter Ranch Pueblo as an example of the use of the D-N model in archeological reasoning. Their position was countered by Morgan (1973) who felt that they had naively reached into the literature of the philosophy of science and had taken the D-N model out of its context. In so doing, they had ignored the fact that philosophers of science disagree among themselves as to what constitutes acceptable explanation and that many philosophers of science espouse other forms of explanation. Morgan also contended that Longacre's Carter Ranch study was not an example of D-N reasoning but only of general scientific hypothetico-deductive reasoning. Watson, LeBlanc, and Redman (1974) responded to Morgan but seem to have missed the point of his criticism. Morgan (1974) replied once more and reiterated his previous criticism, again pointing out that, if one consults a number of sources in the philosophy of science literature, not simply the work of Hempel and Oppenheim, it is apparent that philosophers accept many forms of explanation besides or in addition to the one involving the gen requirement.

Hypothetico-deductive explanation, which is suggested by Morgan (1973) as an alternative to the D-N form of explanation, is common to many sciences and basically consists of the following sequential steps:

Step 1: Observation

Step 2: Hypothesis formulation

Step 3: Prediction based on the hypothesis (specification of test implications).

Step 4: Matching empirical data against predictions. Data analysis is designed to test the validity of the predictions which may or may not be supported. If they are, the hypothesis itself is supported and strengthened; if they are not, the investigator returns to the observational stage, armed with the knowledge that a given hypothesis has been partially or completely eliminated from consideration. Covering laws or general laws do not necessarily have anything to do with this procedure, though one should be aware that any hypothesis under consideration has the potential for eventually developing into a law-like statement of relationship. However, a hypothesis is a hypothesis in its own right and does not derive its scientific validity from its status as a potential law.

If anthropology aspires to be a science and if "The function of science . . . is to establish general laws covering the behavior of the empirical events or objects with which the science in question is concerned . . ." (Braithwaite 1953:172), then indeed anthropologists must attempt to establish general laws. The way in which general laws eventually derive from specific hypotheses is another widely debated issue in the philosophy of science (see Braithwaite 1953) and cannot be dealt with here. But it should be pointed out that the issue is more complex and involved than arriving at general laws simply be asserting that our hypotheses are hypothetical laws (Watson, LeBlanc, and Redman 1971:52) which, once confirmed, move a little closer to becoming established laws.

Recently, R. Watson (1976) has argued that archeology can and should originate new laws. Though his position is not made very clear, he apparently also supports the notion that any valid explanation should meet the gen requirement. This position raises a contradictory point. How can archeology or any other discipline originate new laws by testing hypotheses if all of our hypotheses (hypothetical explanations) must be deductively derived from existing laws? If the formulation of any hypothetical explanation presupposes the recognition of the law from which it is deduced, in which case the law must already be established, then scientists are engaged in the meaningless pasttime of telling us what we already know.

Having decided to operate with an H-D approach, one faces the problem of the form that hypotheses should take. Blalock (1972:112-116) has dealt with this matter, and my position derives from his discussion. In that they have conceptual existence only, hypotheses are never directly tested, but rather tests of their validity are made empirically on consequences drawn from them. A given hypothesis A logically implies certain consequences B; and we say if A is true, B must also be true. Upon testing, if B is found to be false, then the hypothesis must also be false, if the logic has been correct. However, if B turns out to be true, it does not necessarily follow that A is also true. It may be the case that some alternative hypothesis could also account for the conclusion B. If one asserts that A must be true because B is found to be true, then the fallacy of affirming the consequent has been committed. All that can reasonably be concluded is that A may also be true if B is true. On purely logical grounds, hypotheses of the above kind hold that if A is true, B <u>must</u> follow. However, there are also hypotheses of a probabilistic nature which merely hold that if A is true, B will probably also be true. Probabilistic hypotheses allow that consequences B may be false even if A is true. In such cases, the investigator rejects the hypothesis if B proves to be false only with a given level of risk of committing an error. Such an error is called a type I error in statistical jargon, while the possibility of failing to reject a hypothesis when in fact it is false is a type II error (Blalock 1972:115-116).

Although Blalock is looking at the form of hypotheses from the point of view of a statistician, most social science hypotheses have the general nature of probabilistic hypotheses. The hypotheses dealing with changing co-residence patterns in Vosberg Valley offered below are probabilistic in nature, and the predictive statements drawn from the hypotheses do not follow in an unconditional manner. It would be convenient if these hypotheses could be stated so rigorously that, as in statistics, specific confidence levels for rejection or acceptance could be established. However, the validity of our archeological conclusions must, in many cases, be determined on the basis of some vague criterion like reasonableness.

Major Hypothesis

The literature of economic anthropology serves as a source for a hypothesis concerning co-residential changes in Vosberg Valley during the time period in question. Some economic anthropologists feel that, generally speaking, land tenure and land utilization are merely geographical expressions of social organization (see Nash 1964, 1966; Sahlins 1972). Given this proposed interrelationship, it is consistent with a systemic analysis to presume for purposes of establishing a hypothesis that the linkage between land utilization and social organization so operates that changes in one would cause or precipitate accommodative changes in the other. Because they deal with extant peoples, economic anthropologists usually investigate this relationship from a synchronic, functional perspective. From such a perspective, one need not address the question of possible causal connections; interest is generally focused on the role of each variable in maintenance of the social system. However, the data with which archeologists deal not only allows a diachronic perspective but practically demands it. A diachronic perspective, in turn, not only allows an investigation of possible causal connections but also allows one to investigate the temporal direction of causality. Thus, for purposes of the major hypothesis, it is further assumed that changing land utilization practices are causally prior to changing social organization; i.e., changes in the former precipitate accommodative changes in the latter.

Given these assumptions, one is confronted with a need to determine the causality underlying changes in land utilization practices. Again, the literature of economic anthropology offers some possibilities for exploration. A thesis championed by Boserup (1965) postulates that population pressure is a primary causal factor in agricultural technical change and intensification of production. She presents this position in opposition to the neo-Malthusian position which holds that the reverse is true, i.e., that agrarian productivity regulates and maintains population at or below a given level until a new, more efficient means of production comes into being. For purposes of the major hypothesis, it is assumed that a slight variation of Boserup's thesis is essentially correct: it is assumed that sufficient population growth necessitates changes in land utilization practices.

Studies have shown that, in some agrarian societies, land is under control of the members of social units which practice agriculture and which depend upon the products yielded by the land (Brookfield and Brown 1963; Gulliver 1958). In such societies, sufficient population growth can and does initiate changes in land utilization and results eventually in changes in some facets of social organization. In the case studied by Gulliver (1958), population growth and increasing involvement in cash crop production in the Nyakyusa territory of Tanganyika caused a breakdown of traditional land tenure patterns. Prior to population expansion and productive changes, there was no excessive demand for land and even good land went unused. But, at the time of the study, changes were in progress; and virtually 80 percent of all land, good and marginal, was sown to rice crops. New kinship attitudes and a redefinition of fraternal relations were emerging as inheritance, which previously followed no rigid scheme, came into the hands of eldest sons who then divided inherited land among male siblings. Land possession which had always been vested in village units was strengthened and reenforced as village headmen came to be the prime movers in land-holding changes.

The interrelated changes discussed by Gulliver (1958) exemplify the existence of functional integration among the constituent parts of human society, a property of society which has long been recognized (Malinowski 1944; Radcliffe-Brown 1952). Recently adopted systemic ideas acknowledge such social functional integration but additionally posit that functional integration exists between a society and surrounding environmental factors (see Clarke 1968). However, those holding a systemic view would not expect population growth to lead to agricultural technical change in a one-to-one, predictable manner. Simply knowing an initial population size and the magnitude of its growth over a given period of time, one would not expect to be able to predict the resultant land utilization practices. Neither would changes in land utilization practices be expected to lead to social reorganization in a one-to-one manner such that one could predict the consequent form of organization given a knowledge of these practices. Consideration must be given to the role of other variables in these changing relationships. Since a successful agricultural mode of subsistence requires land which will produce a reasonable return for labor invested, the nature of the land itself becomes an important consideration. Variability in physical factors, such as climate,

topography, hydrography, and soils, produces land which varies in its capacity to support the growth of agricultural crops. Additionally, it must be recognized that the natural agricultural potential of land can be altered through technological interference by man (see Ferdon 1959). Thus, factors such as land availability and variation in the natural productive capabilities of the land, as well as technological measures instituted by the group involved, will condition any social reorganization resulting from population expansion mediated through changing land utilization practices.

The preceding considerations offer the ingredients for a hypothesis specific to changes in Vosberg Valley. Hypothesis: Co-residential change in Vosberg Valley during the A. D. 1050 to 1250 time period was ultimately brought about by expansion of population, but only in accord with other conditioning factors. Settlement patterns early in the period reflect a situation wherein daughter social units (i.e., residence elements) resulting from population growth budded off and moved to unoccupied, potentially productive areas and established new agricultural plots. Population growth then continued to the point that the physical or geographical limits of agriculturally suitable land were reached. As these limits were approached, newly forming residence elements began to remain at the locus of the parent unit, and site size increased. This emerging pattern was maintained through technological intensification of productivity on already established fields, located on plots of land having higher agricultural potential.

Secondary Hypotheses and Test Implications

The major hypothesis, though stated in terms specific to Vosberg Valley, is still rather vague and general. As stated, it has only a loose relationship to actual prehistoric changes which took place in the valley and does not readily allow direct testing. Therefore, it is necessary to formulate a number of secondary hypotheses more directly related to the data. Each secondary hypothesis is designed to test one of the principal propositions presented in the major hypothesis in accordance with the kinds of data available from Vosberg Valley. A set of test implications follows each secondary hypothesis.

Chenhall (1972) has proposed that, of the sites in the valley with associated architectural remains, the smaller ones were seasonally occupied field houses, while the larger, aggregated ones served as habitation centers. A contrary position is taken in the following hypothesis.

Secondary Hypothesis I: Small sites and large sites were not functionally different but differed only in numbers of rooms present and arrangement of these rooms vis-a-vis one another. Architectural features at sites of both sizes represent full-time habitation rooms with comparable residence elements having occupied each individual structure.

Test Implications:

A. The nature, as opposed to the number and arrangement, of architectural units at the differently patterned sites should remain relatively uniform from site to site; i.e., structure attributes such as floor plan, fire pit placement, building materials, and construction techniques should be comparable between the two kinds of sites.

B. Architectural units and associated materials should indicate full-time occupation of rooms at both kinds of sites by residence elements involved in a full range of tasks (i.e., habitation rooms).

1. A broad variety of artifacts and features indicative of a range of activities such as food storage, food preparation, food consumption, and manufacture of various kinds of tools should be found in structures at both kinds of sites. For example, storage space should be roughly equivalent; manos, metates, and cooking vessels should be present; bowl-jar ratios should be similar; and other artifact categories should generally be equally represented.

2. With regard to economic plant species, pollen data should yield evidence of year-round occupation at both kinds of sites, rather than seasonal occupation of the small, dispersed sites and year-round occupation of the large, aggregated sites.

C. Insofar as structure size is indicative of residence elements, structures at both kinds of sites should compare favorably with the size range of structures in other areas known to have housed nuclear family sized units.

Secondary Hypothesis II: Significant population increase occurred in Vosberg Valley during the A.D. 1050 to 1250 period.

Test Implication: A finely graded site chronology should demonstrate that population, indicated through room counts, increased markedly through this 200-year period.

Secondary Hypothesis III: Variability in physical environmental factors in Vosberg Valley produced different land areas with a range of agricultural capabilities, and good agricultural lands were present in limited amounts.

Test Implications:

A. Analysis of climatic factors in the general area of Vosberg Valley should demonstrate that the entire area was agriculturally marginal.

B. Topographic analysis should disclose agriculturally significant variation in degree and facing of slopes in different parts of the valley.

C. Hydrographic analysis should establish agriculturally significant variation in water availability in different parts of the valley.

D. Soil analysis should show agriculturally significant variability in edaphic factors from one part of the valley to another.

Secondary Hypothesis IV: The greatest numbers and/or densities of rooms are located in areas best suited to agriculture, indicating concentration of population in these areas.

Test Implication: Once a land-capability classification is established (see Secondary Hypothesis III), analysis should disclose greater counts and densities of rooms in the areas of the higher ranked land classes.

Secondary Hypothesis V: Sites temporally near the middle of the sequence, considered as a whole, are generally located in areas of poorer agricultural potential than are those dating to either end of the sequence, considered as a whole.

Test Implication: With low population numbers early in the sequence, there should have been little pressure on available land, and sites of this time should be located on the best land. Under greater population pressure near the middle of the sequence, a number of sites should come to be located on more marginal land. As even greater population pressure occurred, the formation of large sites should have taken place on lands with sufficiently high potential to permit intensification of agricultural production. Some smaller sites should be expected to continue to occur on more marginal lands late in the period.

Secondary Hypothesis VI: Data indicative of technological intensification of agricultural practices are more prevalent and/or more elaborate in the last half of the A.D. 1050 to 1250 period than in the first half.

Test Implication: There should be more agricultural systems dating in the second half of the sequence and/or they should be more elaborate than those associated with sites early in the sequence. For those agricultural sites not in direct association with habitation sites, this same relationship should hold if it is accepted that dating for these agricultural systems can be inferred from the date of the nearest or most accessible habitation sites.

Supportive Hypotheses and Test Implications

In addition to the major hypothesis and related secondary hypotheses, other hypotheses are conceivable which, while not directly derived from the major hypothesis, can be used to support the case for its plausibility.

Supportive Hypothesis I: Gradual co-residential change in Vosberg Valley was brought about through incremental population increase.

Test Implication: Gradual settlement pattern change should be indicated in the archeological record. If some other factor, such as a need for defense, was instrumental in bringing about aggregated sites, then aggregated sites should be expected to appear rather abruptly in the record.

Supportive Hypothesis II: Sites located in areas of poorer agricultural potential were more dependent on hunting activities than were those situated in better agricultural locations.

Test Implication: Tool types present on site surfaces should show differential emphasis on hunting, but not to the degree that functional differences are indicated from site to site.

CHAPTER V

ARCHEOLOGICAL DATA ANALYSES

This chapter is divided into five main sections. In each section, test implications drawn from one or more of the secondary and/or supportive hypotheses are evaluated through analyses of archeological survey and excavation data from Vosberg Valley. The first section examines Secondary Hypothesis I which is concerned with the nature of intersite variability and resident social units of habitation structures. Because Secondary Hypothesis II and Supportive Hypothesis I both deal with demographic variables, they are evaluated together in the second section. Section three tests Secondary Hypothesis III through an analysis of prehistoric agricultural potential, given the specific set of physical environmental parameters present in Vosberg Valley. Then section four examines the problems encountered in attempting to utilize survey transect data from Vosberg Valley in testing several of the hypotheses. As a result of the analysis in section three, eight land-capability classes are established which are then used in the fifth and final section to test proposed relationships between site locations and lands of differing agricultural potential as stated in Secondary Hypotheses IV and V and Supportive Hypothesis II. The remaining hypothesis, Secondary Hypothesis VI, is also tested in section five.

Site Variability: Functional or Temporal?

Secondary Hypothesis I states that, of those sites in Vosberg Valley with room structures present, size differences noted are indicative of change through time rather than differences in function, and that room structures present at large and small sites alike represent full-time habitation rooms, each of which was occupied by comparable social units. Testing this proposition requires both quantitative and qualitative analysis of architectural attributes of dwellings, associated artifactual materials, and information on economic plant species, obtainable through pollen analysis.

Since survey information does not supply the kind of data necessary for testing this hypothesis, the following analyses, comparing large and small sites, are based upon excavated data alone. As will be

pointed out from time to time, the use of this data is not without problems. Each site furnishing comparative data is briefly described below, accompanied by a brief description of the archeological work undertaken at each. Some of the individual room structures at these sites are illustrated in the following pages as examples of the type of architecture present in the valley. The locations of both excavated and surface surveyed sites are shown in figure 19.

AZ P:13:7--This is a multi-component site located just above the valley floor near the end of a colluvial ridge which extends westward from the hills along the eastern boundary of the locality. The bulk of excavations here was done in 1967, but a minor amount of subsequent work was done in 1968 and 1970. Excavated features at the site relate to both a pit house occupation dating about A.D. 900 to 1000 and a later occupation in the A.D. 1050 to 1250 period. The late component consists of four rectangular, boulder-cobble outlined room structures, designated Features 1, 2, 3, and 4, two of which are contiguous (Features 3 and 4). A few more rooms of this same kind are possibly present, but surface evidence is inconclusive. There is also a circular, ceremonial structure (kiva?) at the site which, despite partial excavation, has not been definitely linked to either component, but most probably dates to the time of the pit house occupation. In addition to architectural features, several burials, generally in extended, supine positions, were excavated.

In the years which have elapsed since the initial 1967 excavation of AZ P:13:7, field notes and materials from the site have been examined by a number of persons. As a result, an indeterminate portion of the notes and recovered inventory has become misplaced, which precludes using the remaining material for quantitative comparisons. However, field notes are still available in which room structure attributes are tabulated for Features 1 and 2, allowing the use of this data in comparisons between large and small sites. This does not apply to Features 3 and 4 because excavation of these features was only partial and the data are incomplete. In addition, the information which is included in the available notes is sufficient to permit a presence-absence comparison of material traits with other sites.

AZ P:13:10--Excavations at this site in 1968, 1969, and 1970 revealed a second multi-component site which, in elevation, is slightly

higher than AZ P:13:7 and is situated in a small saddle at the lower reaches of the steep slopes forming the southern end of the valley. The site is relatively large and depositionally very complex, but essentially consists of an early pit house occupation dating about A.D. 900 to 1000 and a later occupation in the A.D. 1050 to 1250 period. Features excavated at the site include both pit houses and boulder-cobble outlined rooms, a plaza area, a number of burials, mostly in extended, supine positions, and the elements of an agricultural system. Quantitative comparisons which follow make use only of the data from five excavated, contiguous, rectangular rooms, designated Features 3, 4, 7, 10, and 11. Figure 2 illustrates the arrangement of these rooms and depicts the presence of a spatial separation between some of them. This open space between adjacent rooms was common for contiguous structures of the period. The five excavated rooms form part of a room block of seven rooms, two of which remain unexcavated. An eighth rectangular room, spatially separated from the room block, which apparently relates to this same time period, was excavated, but deposits here were so badly mixed that an effective separation could not be made between early and late material. Some material excavated from plaza areas and burials also pertains to the late occupation but will not be dealt with in comparing room structures.

This site, with its aggregated, aligned, contiguous rooms is an example of site patterning characteristic of larger sites of the A.D. 1050 to 1250 period.

AZ P:13:19--At the lower end of the next colluvial ridge to the south of AZ P:13:7 is AZ P:13:19, composed of two contiguous, boulder-cobble outlined rooms. Data from one room (figure 3), excavated in 1970, is used in comparisons which follow. In addition to this one room, excavations were carried out in a shallow depression about 10-12 meters to the west in what was at first thought to be a pit house, but instead two large earth ovens, probably contemporaneous with the room, were unearthed. These ovens may have been intrusive into an earlier pit house, but the field season ended before this question could be fully resolved.

The site is a good example of small sites of the A.D. 1050 to 1250 period.

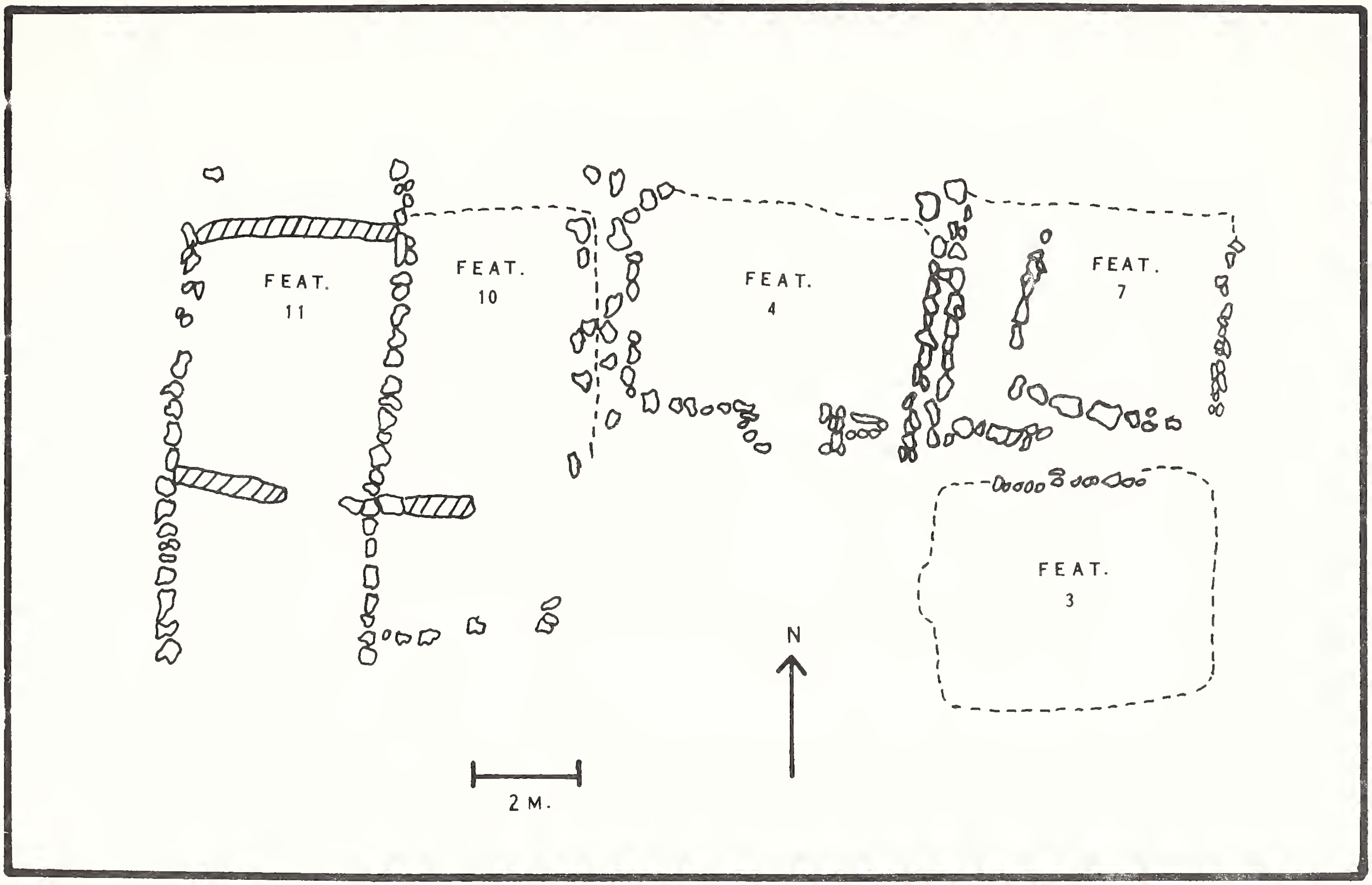


Figure 2. Excavated rooms of AZ P:13:10.

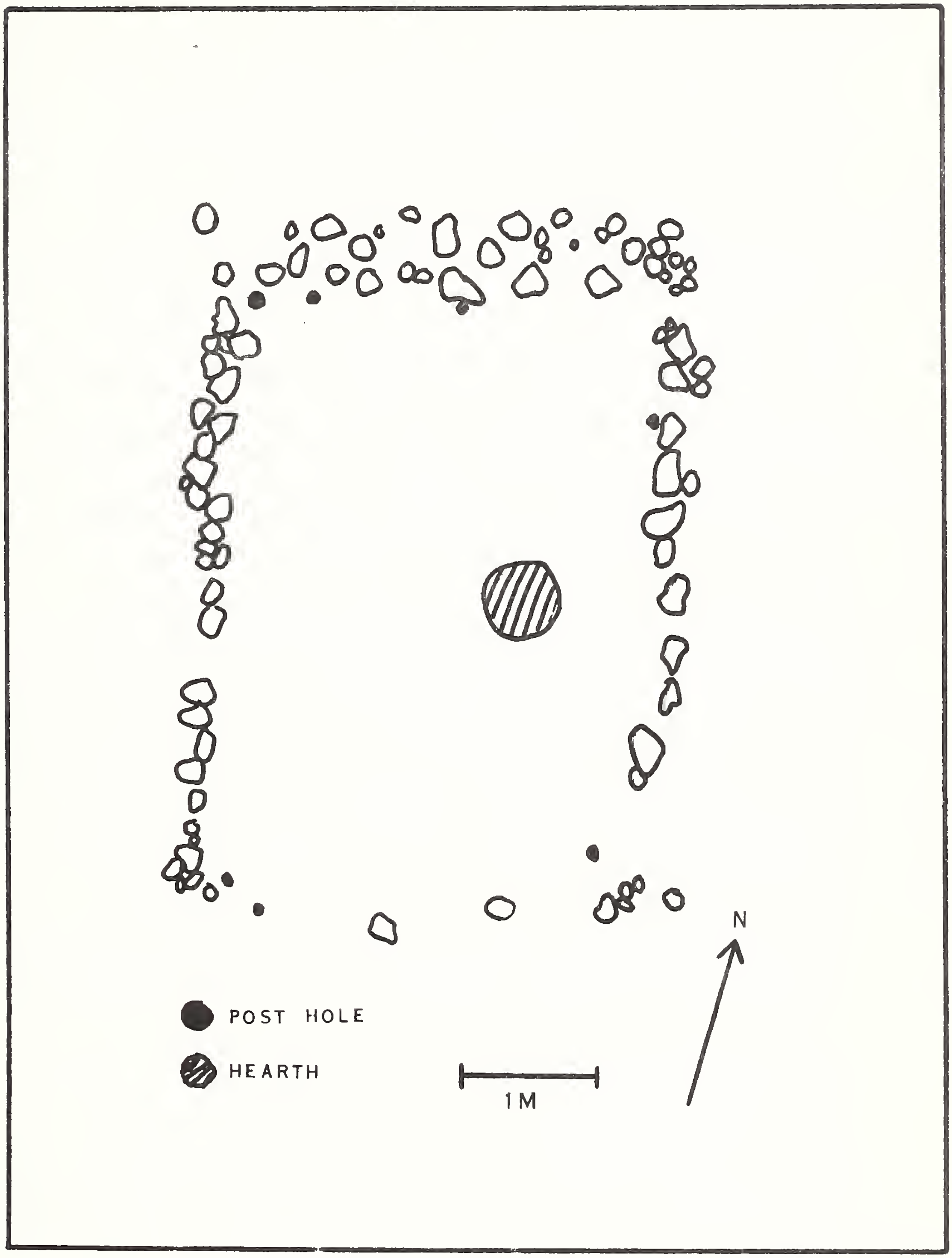


Figure 3. Feature 1 of AZ P:13:19.

AZ P:13:26--This site, which has two spatially distinct units, is situated at a higher elevation than any other excavated site of the A.D. 1050 to 1250 period. It is on the steep slopes of a hill above, and just southwest, of AZ P:13:10. In terms of the broad Vosberg chronology, it is a single component site; i.e., there is no pit house occupation underneath its boulder-cobble outlined rooms. However, rebuilding or remodeling episodes are evident in some of the rooms.

Unit A, the upper unit of the site, consists of at least 16 rectangular, boulder-cobble outlined rooms. These rooms are arranged in four separate blocks of three, five, four, and four contiguous rooms each, schematically depicted in figure 4. The arrangement of separate blocks of rooms takes advantage of naturally occurring small flat areas on the steep hillside. Two contiguous rooms, Feature 1 (figure 5) and Feature 5 (figure 6), as well as the intervening space between them, were excavated in 1970. This data and that from Feature 2, also excavated in 1970, are used for comparisons. Additionally, a single extended, supine burial was excavated outside the entrance of Feature 1.

Unit B, about 100 meters downslope from Unit A, consists of at least 11 rooms. It is composed of one block of six contiguous rooms, a second of four contiguous rooms, and a single room spatially separated from the others (figure 4). One of the rooms, Feature 2, in the block of four rooms and another, Feature 1 (figure 7), in the block of six rooms were excavated in 1970. Feature 1 contained four extended, supine burials laid out on its floor, which, in addition to other attributes discussed below, suggests that Feature 1 may have been a special function room.

AZ P:13:26 is a second example of large sites of the A.D. 1050 to 1250 period. Lack of mixture with earlier materials and well controlled excavation at the site make it an excellent one for comparative purposes.

AZ P:13:29--This small site was excavated in 1969 and 1970. It is located at the end of a colluvial ridge just north of the one on which AZ P:13:7 is located. Thus, AZ P:13:7, AZ P:13:19, and AZ P:13:29 are all small sites located in very similar situations, in the same part of the valley, at about the same elevation. The latter is another multi-component site with rooms of the A.D. 1050

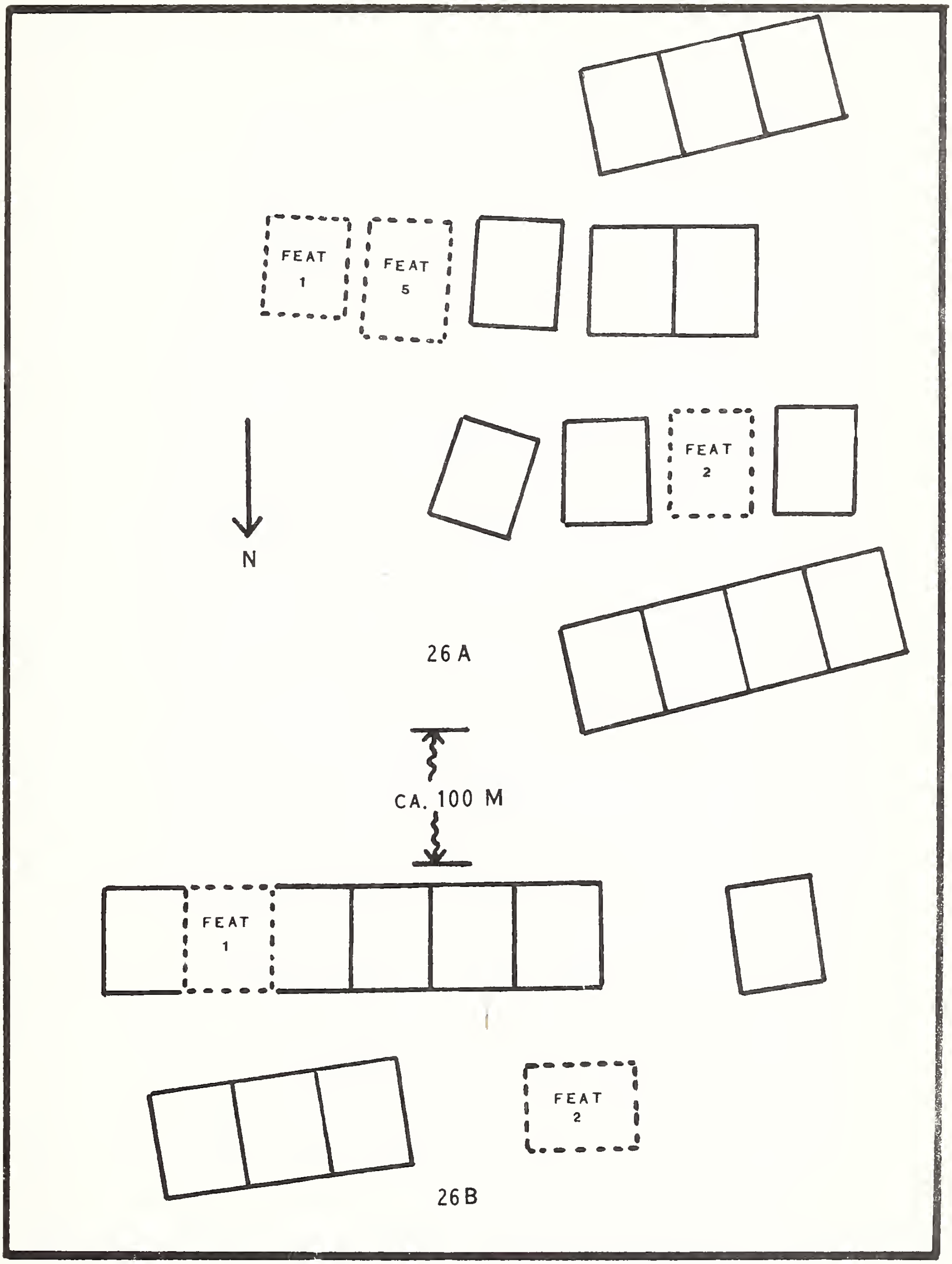


Figure 4. Schematic representation of AZ P:13:26.

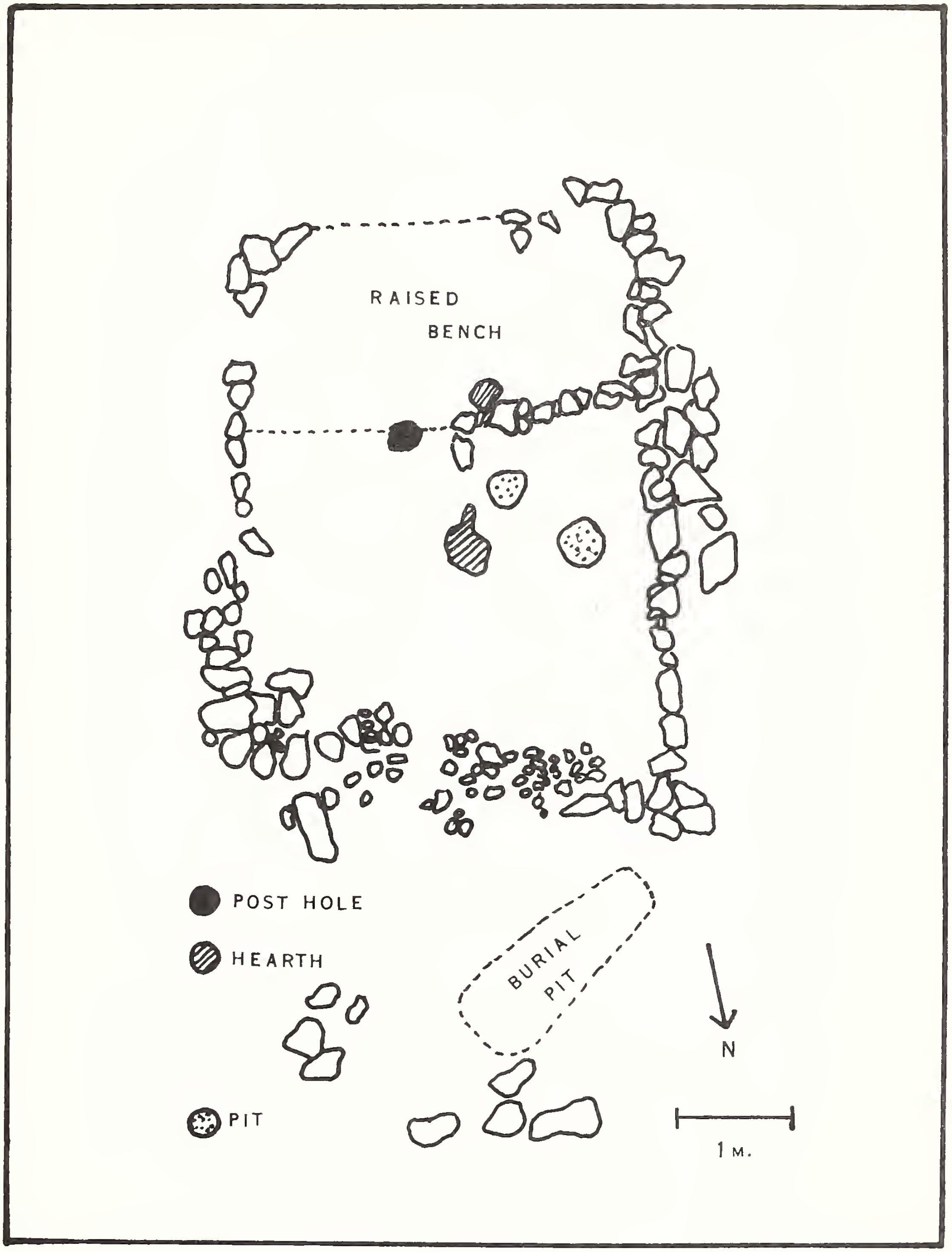


Figure 5. Feature 1 of AZ P:13:26A.

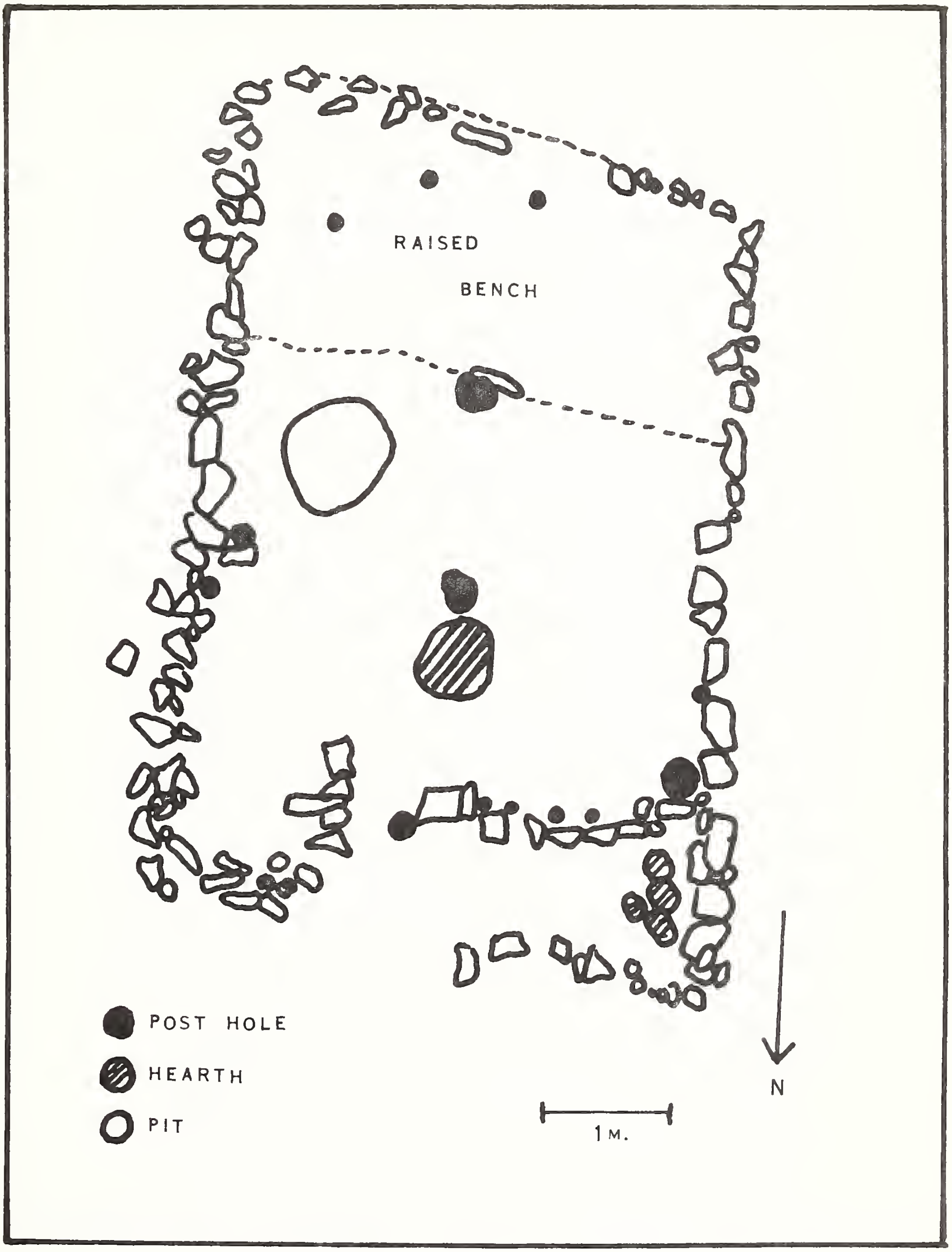


Figure 6. Feature 5 of AZ P:13:26A.

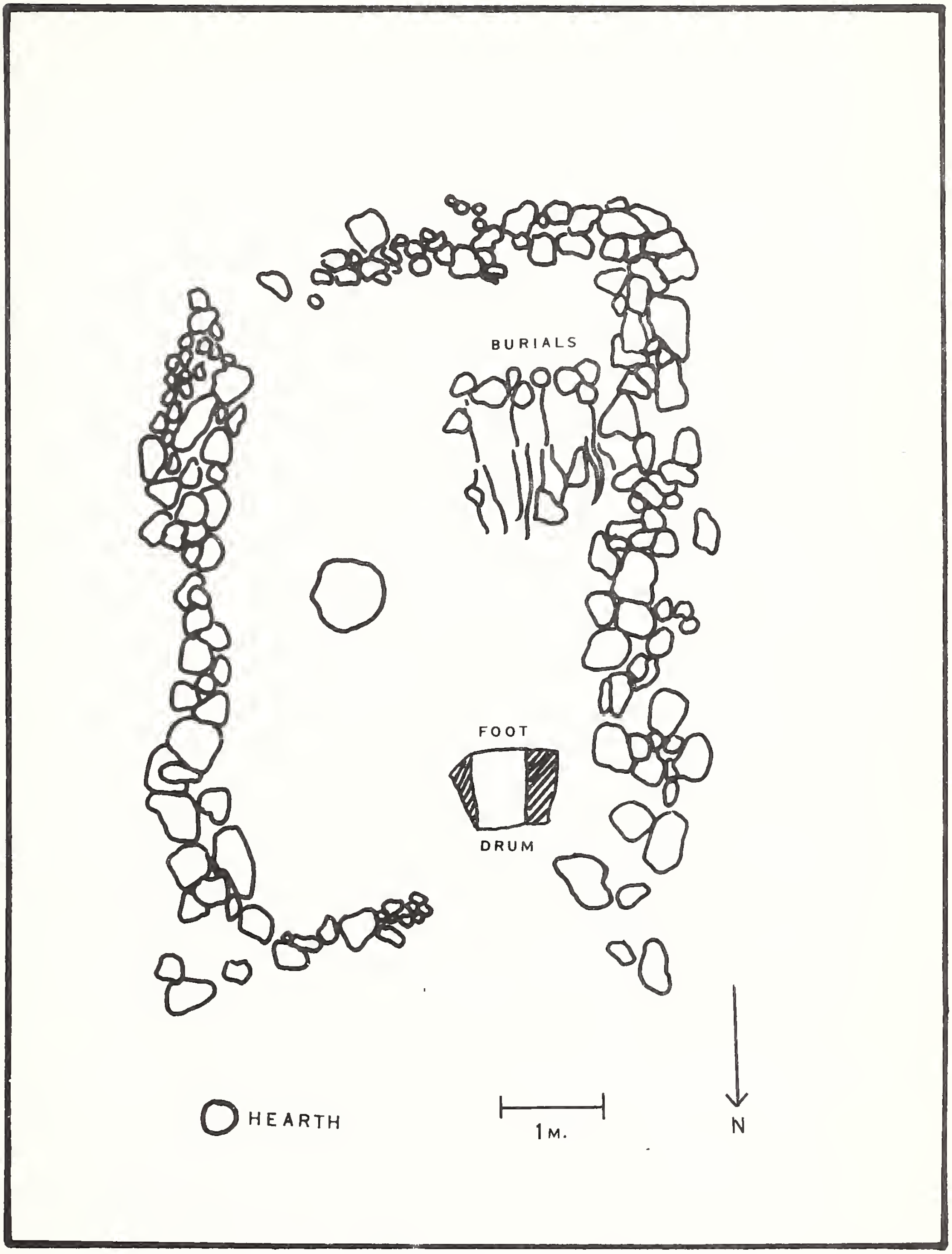


Figure 7. Feature 1 of AZ P:13:26B.

to 1250 period superimposed on pit houses which date about A.D. 750 to 900. The late component consists of two noncontiguous, rectangular, boulder-cobble outlined rooms, both of which were excavated. Materials from this site were not available for quantitative analysis, but presence-absence data, useful for comparative purposes, was obtained from field notes. Field notes also served as a source for room structure attributes which have been used in the following comparisons.

Test Implication A of Secondary Hypothesis I states that the nature of architectural units at differently patterned sites should be relatively uniform from site to site if all sites were functionally equivalent. If the smaller sites were the locus of limited activities or were seasonally occupied, one might expect the rooms to differ from those of larger sites in attributes such as floor space, internal features, and construction techniques and materials. These and other room attributes are compared in table 2 for all excavated rooms of large and small sites.

This comparison reveals no apparent tendency for attributes of rooms of smaller sites to cluster into a grouping distinct from those of the larger sites. All rooms are comparable in rectangular outline. Floor space per room ranges from 15.16 m.^{2} to 30.30 m.^{2}, with an overall mean floor space of 21.21 m.^{2} and a standard deviation of 3.79. Floor space quantities were divided into two samples, one representing rooms of the large sites and the other rooms of the small sites; and the samples are compared in table 3 using a Difference-of-Means Test (see Blalock 1972:220-228). The null hypothesis tested states that there is no significant difference between the mean values of the two samples at a significance level of 0.05. Applying the formula from Blalock (1972:226), a _t_ value of 0.922 with 12 degrees of freedom was calculated, and reference to a _t_ table indicates that the null hypothesis cannot be rejected. It is therefore concluded that no significant difference exists between floor area of rooms at large and small sites.

Table 2 also shows that, with one complete and one partial exception, all rooms had their perimeters lined with boulders and cobbles; site size does not influence this attribute. All rooms had one or more fire hearths, but hearth numbers could not be compared because in several cases it was not determined during excavations how many hearths pertained to different floor levels. In all but

Table 2

COMPARISON OF ROOM STRUCTURE ATTRIBUTES

Sites	Feature	Floor area--m^2	Entry	Internal posts holes	Internal pits	Rectangular outline	Stone-lined	Central fire pit	Raised bench	Internal partition
				Small Sites						
P:13:7	1	22.79	End	1	None	+*	+	0	0	0
P:13:7	2	24.00	End	13	None	+	+	+	0	0
P:13:19	1	15.81	End	7	1 sm.	+	+	+	0	0
P:13:29	2	22.00	End	11	None	+	+	+	0	0
P:13:29	6	15.16	End	24	None	+	0	+	0	0
				Large Sites						
P:13:10	3	20.80	End	38	2 sm.	+	+	+	0	0
P:13:10	4	24.30	Side	54	1 sm.	+	+	+	0	0
P:13:10	7	19.50	Side	44	None	+	+	+	0	+
P:13:10	10	18.00	End	36	1 lg.	+	+	0	0	0
P:13:10	11	22.20	End	20	1 lg.	+	+	+	0	0
P:13:26A	1	24.00	End	1	3 sm.	+	+	+	+	+
P:13:26A	2	22.80	End	0	None	+	+	+	+	0
P:13:26A	5	30.00	End	12	1 lg.	+	+	+	+	0
P:13:26B	1	19.86	End	3	Ft. drum	+	+	0	0	0
P:13:26B	2	16.90	End	11	1 sm.	+	+	+	0	0

*+ = present; 0 = absent.

Table 3

COMPARISON OF ROOM FLOOR AREA: LARGE SITES VS. SMALL SITES IN VOSBERG VALLEY

Rooms of Large Sites		Rooms of Small Sites	
Site and Feature	Floor Area--m^2	Site and Feature	Floor Area--m^2
P:13:10 -- F. 3	20.80	P:13:7 -- F. 1	22.79
P:13:10 -- F. 4	24.30	P:13:7 -- F. 2	24.00
P:13:10 -- F. 7	19.50	P:13:19 -- F. 1	15.81
P:13:10 -- F. 10	18.00	P:13:29 -- F. 2	22.00
P:13:10 -- F. 11	22.20	P:13:29 -- F. 6	15.16
P:13:26A -- F. 1	24.00		$\bar{x}$ = 19.95
P:13:26A -- F. 2	22.80		o = 3.71
P:13:26A -- F. 5	30.00		
P:13:26B -- F. 2	16.90		
	$\bar{x}$ = 22.05		
	o = 3.74		

$\underline{t}$ = 0.922

d.f. = 10

Significance level = 0.05

three cases, rooms had centrally located hearths, but the rooms with noncentered hearths occur at both large and small sites; and there is no correlation with site size. The normal mode of entry into rooms was through one end. There are two exceptions to this, but since both occur at the same site it seems unrelated to site size. There is a raised bench area present in the rear portion of three rooms, all of which occur at Unit A of AZ P:13:26. Such a restricted distribution of this feature seems best interpreted as a construction preference by the members of a single social group. There is wide variation from room to room in the number of internal post holes recorded, most of which is probably accounted for by differential preservation and differential recognition of post molds during excavation. Internal room partitions appear in a few rooms but are too infrequent to pattern by site size.

The only discernible patterned difference between the attributes of rooms at small sites and those at large sites is in internal pit features. A single, small pit was found in one of the rooms at one of the small sites, while pits were found in most of the rooms at large sites. However, if the pits discovered were indeed storage pits, none are of sufficient size to account for storage requirements one might expect. Large pits in some rooms average around 0.35 $m.^3$ in capacity with the largest recorded having a volume of only about 0.5 $m.^3$, but most of the pits are quite small and extremely shallow, having an average volume around 0.10 $m.^3$ with the smallest around 0.01 $m.^3$. Some of the small pits were ash filled. The difference between rooms at the two sizes of sites with regard to internal pit features is evident, but the meaning of this difference is not clear.

Some, but not all, excavated rooms produced enough information to allow a reasonable inference concerning the type of superstructure present. Post molds were most often found immediately inside the boulder-cobble lined room perimeters, suggesting the former presence of upright posts. Fire-hardened mud containing wooden post and beam impressions was also recovered in a number of rooms, which further suggests that room superstructures were of jacal, plastered onto wooden frameworks. At least one exception tothis is Feature 1 at AZ P:13:26B (figure 7) where the intact boulder-cobble walls of the structure were almost a meter high. There were enough other boulders and cobbles present in the fill to indicate that the stone walls probably supported the roof directly instead of serving as a lining between a jacal wall and the pit edge.

This feature differed in other respects: it contained but a small quantity of artifacts and debris; it was the only feature with an internal pit which apparently served as a foot drum; and there were four adult male (?) burials laid out side by side directly on the floor, sparingly covered by a few boulders placed over the bodies. Rooms at other sites did sometimes contain burials, but all were single interments in sub-floor pits. An interpretation of a ceremonial structure seems reasonable for this feature and, thus, it does not characterize rooms of large sites in contrast to those of small sites. Though this evidence is not sufficient to indicate site functional differences, it does suggest that the advent of large sites was accompanied by the addition of special function rooms.

The preceding comparisons support Test Implication IA. At large and small sites alike, rectangular, boulder-cobble outlined rooms of a fairly uniform size, usually having a centrally located fire hearth and an entrance at one end, were constructed in shallowly excavated depressions. Other construction attributes were noted, but none patterned according to site size. Superstructures were apparently composed of jacal with one clear exception which suggests that special function rooms were associated with large sites.

Analysis required by Test Implication IB is designed to examine two problems simultaneously. Based upon the assumption that comparable kinds and quantities of materials in rooms should indicate functional similarities or differences, materials associated with rooms are compared first as a means of investigating the proposed functional equivalence of rooms. Secondly, this kind of comparison leads to a delineation of the behavioral tasks represented by the materials. The range of behavior(s) represented, in turn, allows inferences concerning the nature of social units which resided in the rooms.

In dealing with material from rooms, it was my original intent to assess functional similarities and differences by restricting comparative analysis to only that material in association with room floors. However, this strategy proved unworkable. If room floors were plastered originally, which seems generally not to have been the case in Vosberg Valley, the plaster was not preserved well. As a result, floors were not easily detected by excavators, in some cases not at all, and those which were detected were often found as broken and isolated patches, severely

disturbed by rodent activity. In several rooms, excavators felt that evidence indicated two or three floor remodelings, but differences were often so vague and confused that most material could not be assigned to specific floors. Of the materials which could be assigned to a specific floor provenience, the quantity is often insufficient for meaningful comparison. For example, two floors were defined for Feature 1 at AZ P:13:19, and even though it was possible to establish some associations specific to each floor, the total number of objects thus assigned was only 103. Of this number, 94 objects (91 percent) are sherds and lithic chipping debris, and the nine remaining objects simply are not sufficient as a meaningful comparative sample.

Since floor association data could not be used, it was decided that all materials excavated within the boundaries of each room would be quantified and compared where such data could be ascertained. Such a comparison is less secure, but it yields an index of the degree of similarity between rooms and is preferable to the alternative of no comparison at all. Because the data of sites AZ P:13:7 and AZ P:13:29 was unavailable for study, the analysis necessarily incorporates only one example of a small site room.

Materials from each room were first sorted into classes on an impressionistic basis: rigorous analytic techniques such as microscopic wear analysis or edge angle analysis were not employed. Using this procedure, 82 relatively exclusive categories were recognized, all of which are listed in table 4 to afford the interested reader a relatively detailed accounting of the kinds and quantities of materials recovered. However, to facilitate written descriptions, similar objects from the 82 categories were lumped into more inclusive groups, resulting in the 31 classes described below. Representative items for some of these descriptive categories are shown in plates I through XXVII (see appendix).

Materials from Rooms

Manos (plates I and II). Both one-handed and two-handed type manos were recovered in room excavations. The two-handed type, numerically the most frequent, is generally rectangular while most of the one-handed manos are sub-rectangular to rounded. Both are usually made of granitic rock. Vesicular basalt, commonly used for manos elsewhere, was not used in Vosberg Valley.

Table 4

ARTIFACTS AND DEBRIS FROM ROOM UNITS

Material	AZ P:13:19 Feature 1	AZ P:13:26A Feature 1	AZ P:13:26A Feature 2	AZ P:13:26A Feature 5	AZ P:13:26B Feature 1	AZ P:13:26B Feature 2	AZ P:13:10 Feature 3	AZ P:13:10 Feature 4	AZ P:13:10 Feature 7	AZ P:13:10 Feature 10	AZ P:13:10 Feature 11
Mano	-	2	3	7	3	3	9	4	4	7	15
Metate	4	-	3	3	-	-	5	9	2	7	1
Hammer stone	1	5	1	-	1	-	15	6	3	24	29
Pecking stone	-	-	1	1	-	-	1	1	-	2	1
Core	1	-	2	4	-	-	16	5	6	11	8
Unid. biface	2	-	7	4	1	-	5	3	2	2	7
Projectile point	4	8	7	20	3	3	31	12	17	20	16
Drill	-	-	2	5	-	-	5	3	-	3	6
Flake drill	-	-	-	3	-	-	-	-	-	2	4
Knife	2	-	-	5	-	-	2	-	-	-	-
Flake knife	1	-	-	-	-	-	-	3	1	-	1
End scraper	1	1	-	-	-	-	-	-	-	-	-
Flake end scraper	1	-	1	1	-	-	2	1	1	1	1
Side scraper	1	-	-	-	-	-	-	1	-	-	-
Flake side scraper	2	7	4	5	-	5	10	2	2	5	10
Utilized flakes	41	109	283	205	15	63	198	70	58	225	447
Flake graver	-	-	-	-	-	-	1	-	-	-	-
Util. flake blade	-	1	3	6	-	-	2	1	-	-	1
Util. flk., obsidian	-	-	-	-	-	-	2	-	-	-	-
Flake blade	-	-	3	3	-	1	-	-	-	-	3
Debitage	116	166	871	283	27	188	674	142	183	991	1438

Table 4--Continued

Material	AZ P:13:19 Feature 1	AZ P:13:26A Feature 1	AZ P:13:26A Feature 2	AZ P:13:26A Feature 5	AZ P:13:26B Feature 1	AZ P:13:26B Feature 2	AZ P:13:10 Feature 3	AZ P:13:10 Feature 4	AZ P:13:10 Feature 7	AZ P:13:10 Feature 10	AZ P:13:10 Feature 11
Hoe or chopper	-	-	-	1	-	-	-	1	2	-	1
Anvil stone	-	-	-	-	-	-	1	1	-	-	1
Lg. polishing stone	-	-	-	-	-	-	-	1	1	2	1
Sm. polishing stone	-	-	-	-	-	-	3	1	1	-	5
Sm. grinding stone	-	1	-	-	-	-	-	-	-	-	-
Pestle	-	-	-	-	-	-	-	1	-	-	-
3/4 grooved ax	-	-	-	-	1	-	-	-	-	1	-
Ax, limestone	-	-	-	-	-	-	-	1	-	-	-
Ax, steatite	-	-	-	-	-	-	-	-	-	1	-
Awl sharpener	-	-	-	-	-	-	-	-	-	-	1
Shaft straightener	-	-	-	-	-	-	-	-	-	2	1
Bone awl	-	-	1	1	-	-	1	1	-	3	-
Spindle whorl	1	-	-	-	1	1	4	3	5	5	7
Unworked steatite	-	1	-	-	-	-	4	1	1	11	19
Worked steatite	3	1	2	4	-	-	19	1	8	13	12
Unworked serpentine	-	-	-	-	-	1	1	-	-	2	-
Worked serpentine	-	-	-	1	-	-	-	-	-	-	1
Unworked hematite	-	-	-	-	2	-	1	-	2	-	7
Worked hematite	-	-	1	2	-	1	2	-	-	3	2
Unworked turquoise	-	-	-	-	-	-	-	-	-	1	-
Worked turquoise	-	-	-	2	-	-	1	1	-	-	2
Magnetite	-	-	-	-	-	-	-	1	-	2	-
Galena	-	-	1	1	-	-	-	-	-	-	-
Pipestone	-	-	-	-	-	-	2	-	-	-	-

Table 4--Continued

Material	AZ P:13:19 Feature 1	AZ P:13:26A Feature 1	AZ P:13:26A Feature 2	AZ P:13:26A Feature 5	AZ P:13:26B Feature 1	AZ P:13:26B Feature 2	AZ P:13:10 Feature 3	AZ P:13:10 Feature 4	AZ P:13:10 Feature 7	AZ P:13:10 Feature 10	AZ P:13:10 Feature 11
Quartz	-	-	-	-	-	-	1	-	-	-	1
Schist	-	-	-	1	-	-	-	-	-	-	-
Asbestos	-	-	-	-	-	-	1	-	-	-	-
Ring, steatite	-	-	-	-	-	-	1	1	-	-	1
Ring, pipestone	-	-	-	-	-	-	1	-	-	1	-
Ring, bone	1	-	-	-	-	-	-	-	-	-	-
Bead, steatite	-	-	-	-	1	-	1	1	-	2	-
Bead, serpentine	-	-	-	-	-	-	1	-	-	-	1
Bead, shell	-	-	-	2	-	-	2	-	-	1	1
Bead, clay	-	-	-	1	-	-	-	-	-	2	-
Bead, crinoid	-	1	1	-	-	-	2	-	-	-	3
Pendant, steatite	-	-	-	-	-	-	1	-	-	1	6
Pendant, serpentine	-	-	2	-	-	-	-	-	-	-	1
Pendant, turquoise	-	-	-	1	-	-	1	1	-	-	-
Pendant, shell	-	-	-	1	-	-	-	-	-	-	-
Disk, steatite	-	1	-	-	-	-	-	-	-	-	1
Disk, limestone	-	-	-	-	-	-	1	-	-	-	-
Disk, sandstone	-	-	-	-	-	-	-	-	-	1	-
Bracelet, shell	-	-	-	-	-	-	2	-	-	-	-
Tinkler, shell	-	-	-	1	-	-	-	-	-	-	-
Unid. ornament frg.	-	-	-	-	-	-	2	-	-	-	-
Deer figurine, clay	1	-	6	3	-	-	2	1	-	7	4
Pig figurine, clay	-	-	-	-	-	-	1	-	-	-	-

Table 4--Continued

Material	AZ P:13:19 Feature 1	AZ P:13:26A Feature 1	AZ P:13:26A Feature 2	AZ P:13:26A Feature 5	AZ P:13:26B Feature 1	AZ P:13:26B Feature 2	AZ P:13:10 Feature 3	AZ P:13:10 Feature 4	AZ P:13:10 Feature 7	AZ P:13:10 Feature 10	AZ P:13:10 Feature 11
Horn toad fig., clay	-	-	-	-	-	-	-	-	-	-	1
Unid. figurine fragment, steatite	-	-	-	-	-	-	-	-	1	-	-
Effigy ax, steatite	-	-	-	-	-	-	-	-	-	1	-
Effigy bowl, steatite	-	1	-	-	-	-	-	-	-	-	-
Clay coil	-	1	5	1	-	-	5	2	2	7	14
Pipe fragment, clay	-	-	-	-	-	-	1	-	-	2	2
Shell fragment	-	-	-	-	-	-	4	-	-	1	4
Sherds	507	3091	5470	3121	628	1502	4397	2007	2109	7846	12686
Worked sherds	-	-	-	-	-	-	4	1	-	2	-
Bone tube	-	-	-	-	-	-	-	-	-	-	1
Unid. worked bone	-	-	-	-	-	-	1	2	1	1	2
Deer bone	P	P	-	P	-	-	P	P	P	P	P
Rodent bone	-	P	P	P	-	-	P	P	-	P	P
Bird bone	P	-	P	P	-	-	P	P	P	P	P

Metates. With two exceptions, all of the complete metates and classifiable fragments are of the trough type. The two exceptions are shallow basin metates. Like the manos, they are usually made of granitic rock, but occasionally, a fine-grained sandstone was used.

Hammer and Pecking Stones (plate III). These two artifact types have been grouped into a single class. The distinction between these two kinds of stone-working tools is one of size, with no absolute dividing line. Hammer stones are relatively large and heavy while pecking stones are smaller and lighter. Several kinds of stone were used, but most common is chert.

Cores. This category consists of spent and partially spent chert cores of various sizes, resulting from the manufacture of stone tools.

Unidentified Biface Fragments. A number of fragmentary, chipped stone objects which could not be otherwise classified are included in this category.

Projectile Points (plates IV through XIII). Side-notched, corner-notched, and un-notched chipped stone projectile points are found at all sites in Vosberg Valley. Most of these points, which presumably functioned as tips for arrow shafts, are less than 3 cm. in length.

Drills (plates XIV and XV). A variety of drills is represented in the Vosberg material; some are T-shaped, some have flared, expanded bases, and some consist of only a straight shaft. Flake drills have been grouped with this category in addition to the few broken projectile points which have been reworked into drills.

Knives (plate XVI). A number of objects in this category might just as easily have been classified as projectile points except that, when intact, these knives are larger than most of the objects classified as projectile points. Many are fragmentary, and it is now impossible to discern their exact original size and shape. This category also includes the few flake knives which were recovered.

Scrapers. Very few of these objects seem to have been formally manufactured as scrapers in that most are flakes of various sizes which, according to visual inspection, show the sort of wear which

results from use in a scraping manner. All four categories of scrapers in table 4 have been included here; this includes both end and side scrapers, the latter of which are the most numerous.

Hoes or Choppers. This category includes large, flattened pieces of stone which have had large flakes crudely removed from one edge. Presumably, they functioned as hand-held chopping tools.

Anvil Stones. Objects have been classified as anvil stones on the basis of battering marks on one surface. These rather amorphous stones apparently provided a surface on which other stone materials were chipped and worked.

Large Polishing Stones. These are rather large, sub-rectangular to rounded stones which are similar in most respects to one-handed manos, but the principal difference is that one surface has been worn smooth by either a rubbing or polishing motion. Such stones are sometimes called floor polishing stones, but there is no reason why they need have had such a restricted function.

Small Polishing Stones. For the most part, these objects are water worn pebbles which, to judge by the extreme smoothness and wear on one surface, have been used to polish other surfaces. Their specific use was probably in polishing the surfaces of ceramic vessels.

Small Grinding Stones. A category separate from metates was established for one small stone. Wear on one surface indicates its use as a nether stone in a grinding process. Bits of ground hematite were discernible in the pores of the grinding surface.

Pestle. A single object has been classified as a pestle. It is a long, cylindrical stone tool, presumably used for grinding and/or crushing in conjunction with a mortar or a basin metate.

Axes (plates XVII and XVIII). Included in this category are a single-bitted, 3/4-grooved ax, a full-grooved, double-bitted ax of limestone, and a fragment of what appears to have been a 3/4-grooved ax of steatite.

Awl Sharpener. This category includes one roughly rectangular piece of sandstone with a small, V-shaped groove worn into one surface, apparently used in sharpening bone awls.

Shaft Straighteners (plate XIX). These are grooved stones, thought to have been used as arrow shaft straighteners, one of which is made of serpentine. The other two incomplete specimens are of limestone.

Bone Awls (plate XX). The sharp pointed bone tools in this category were manufactured from deer bone.

Spindle Whorls (plate XXI). All spindle whorls recovered were made from pottery sherds which were worked into a circular shape and then had holes drilled through their centers.

Minerals. A number of mineral substances occur naturally in the area around Vosberg Valley. The prehistoric inhabitants of the area used several of them for such things as ornaments and figurines, as well as a few utilitarian items. Included in this class are all of the unworked raw materials listed in table 4, as well as worked fragments which cannot be identified as any particular object. Mineral substances used include steatite, serpentine, hematite, turquoise, magnetite, galena, pipestone, asbestos, quartz, and schist.

Ornaments (plates XXII through XXV). This class includes various items thought to have been used for personal adornment. Included are rings of steatite, pipestone, and bone; beads of steatite, serpentine, shell, clay, and crinoid fossils; pendants of steatite, serpentine, shell and turquoise; disks (probably pendant blanks) of steatite, limestone, and sandstone; bracelets of shell (Glycymerus); a shell tinkler; and an unidentified stone ornament fragment. A number of these ornaments were associated with burials in pits beneath room floors.

Figurines and Effigies (plates XXVI and XXVII). Figurines recovered from the rooms, with the possible exception of unidentified fragments, were all animal forms. Most of them appear to be deer figurines, but there is one pig (javeline), and one probable horned toad. All but one figurine was constructed in clay. A small effigy of a bowl, another of an ax, and an unidentified figurine fragment were made of steatite.

Clay Coils. This is a category of rolled, cylindrical pieces of fired clay, many of which appear to be fragments (limbs?) from clay animal figurines, but some of which are probably clay coils produced in the manufacture of ceramic vessels.

Ceramic Pipes. A few fragmentary ceramic objects appear to have been parts of tobacco smoking pipes, but because they are so fragmentary, this classification is questionable.

Shell Fragments. Shell fragments recovered are all small, and no species identification is possible.

Worked Bone. This category includes one bone tube fragment and a few unidentified, worked bone fragments.

Utilized Flakes. Included here are flakes produced during chert knapping which were subsequently minimally used, most for some unknown purpose. The criterion for inclusion in this category is the presence of tiny, but macroscopic, usage scars along the edges of the flakes. A single flake graver and utilized flake blades were also placed in this category.

Lithic Debitage. All chipping debris which showed no evidence of usage is included in this category.

Ceramic Sherds. All pottery fragments, a few with one or more edges smoothed or ground, were placed in this category.

Faunal Bone. Bone generally was not preserved well in the soil present in Vosberg Valley. Deer, rodent, and bird bone were recognized, but a more refined classification was not attempted.

The question of functional equivalence between rooms may be addressed through a statistically based comparison of the assemblages of material found in each. However, a number of the preceding categories of material are represented by just one or a few items in one or two given rooms, often at the same site; and, therefore, it has been necessary to formulate still more inclusive comparative categories, yielding numerical frequencies in each category sufficiently large to allow acceptable statistical manipulation of the data. Because the underlying concern is with functional similarities or differences, further grouping along functional lines is a logical choice. Functional groups thus formulated are presented in table 5, followed by a tabulation of the various categories of material comprising each. Comparison of this table with the 31 categories listed above indicates that not all materials are included in table 5. This is because not all materials recovered could be acceptably placed

Table 5

FUNCTIONAL CATEGORIES OF SELECTED MATERIAL FROM ROOM UNITS

Functional Category	Materials Included
Food Grinding Tools	Manos, metates, and pestles
Food Serving Utensils	Ceramic vessels
Household Tools	Drills, awls, awl sharpeners, small grinding stones, large and small polishing stones, and spindle whorls
Tool Manufacturing Tools and Waste	Hammer stones, pecking stones, anvil stones, cores, and debitage
Hunting Tools	Projectile points, knives, scrapers, and shaft straighteners
Multi-use Tools	Utilized flakes
Ritual and Adornment Items	Minerals, ornaments, figurines, effigies, ceramic pipes, and clay coils

into functional categories of sufficient size for meaningful quantitative comparison. Exclusion of these few categories (unidentified biface fragments, hoes, axes, shell fragments, worked bone, and faunal bone) is not considered critical to the potential validity of comparative analysis. Admittedly, some of the materials in table 5 could conceivably be placed in more than one of the functional categories, but placement in the selected category was based on an assumed primary functional context.

The numerical frequencies of items in each functional category are tabulated in table 6 for all excavated rooms at AZ P:13:19, AZ P:13:26, and AZ P:13:10. Since this data constitutes a nominal scale of measurement, chi-square serves as an appropriate test for comparison of samples. Assessment of functional similarity or difference required a comparison between all combinations; and, since 11 different rooms are involved, the possible combinations add up to 10!, or 55. However, valid use of the chi-square test requires that, when df is larger than one, fewer than 20 percent of the cells should have an expected frequency of less than five (Siegel 1956:178). Observance of this requirement eliminated 22 of the possible combinations from consideration. The two rooms of AZ P:13:26B with their low frequencies in three categories each could not be statistically compared to any of the other rooms, which alone accounts for 19 of the 22 eliminated combinations. Two more possibilities were eliminated between Feature 1 of AZ P:13:19 and Features 1 and 2 of AZ P:13:26A; the remaining eliminated possibility was that between Features 1 and 2 of AZ P:13:26A.

Chi-square tests were thus applied to a total of 33 different combinations of rooms. In order to illustrate the technique, one example has been selected and is presented in table 7. The null hypothesis in this, and all cases tested, is that the two sample frequencies have come from the same or identical populations. To test this, expected frequencies are first calculated from marginal totals, and $\underline{X}^2$ is then computed according to the formula in Siegel (1956:46). In this example, an $\underline{X}^2$ value of 8.80 was calculated with six degrees of freedom. Reference to a table of critical values for chi-square indicates that the null hypothesis cannot be rejected, and it is concluded that these two samples were drawn from the same or identical populations, indicating functional equivalence between the two rooms compared.

Table 6

NUMERICAL FREQUENCIES OF MATERIAL
IN FUNCTIONAL CATEGORIES

Functional Category	AZ P:13:19 Feature 1	AZ P:13:26A Feature 1	AZ P:13:26A Feature 2	AZ P:13:26A Feature 5	AZ P:13:26B Feature 1	AZ P:13:26B Feature 2	AZ P:13:10 Feature 3	AZ P:13:10 Feature 4	AZ P:13:10 Feature 7	AZ P:13:10 Feature 10	AZ P:13:10 Feature 11
Food Grinding Tools	4	2	6	10	3	3	14	14	6	14	16
Food Serving Utensils	507	3091	5470	3121	628	1502	4397	2007	2109	7846	12686
Household Tools	1	1	3	9	1	1	13	9	7	15	24
Tool Manufacturing Tools and Waste	118	171	878	291	28	189	707	155	192	1028	1480
Hunting Tools	12	16	12	31	3	8	45	19	21	28	29
Multi-use Tools	41	110	286	211	15	63	203	71	58	225	448
Ritual and Adornment Items	5	6	18	21	3	2	56	10	14	57	79

Table 7

CHI-SQUARE COMPARISON OF MATERIALS FROM FEATURES 4 AND 7 OF AZ P:13:10

Functional Category	AZ P:13:10 Feature 4	AZ P:13:10 Feature 7	Total
Food Grinding Tools	14	6	20
Food Serving Utensils	2007	2109	4116
Household Tools	9	7	16
Tool Manufacturing Tools and Waste	155	192	347
Hunting Tools	19	21	40
Multi-use Tools	71	58	129
Ritual and Adornment Items	10	14	24
Total	2285	2407	4692

The preceding comparison between Features 4 and 7 of AZ P:13:10 was the only case out of all room comparisons performed in which the null hypothesis of no difference had to be rejected. In other words, 32 out of 33 chi-square tests demonstrated that samples being compared were not drawn from the same or identical populations. These results indicate that not only do the rooms of the large and small sites differ functionally, but additionally, with a single exception, each room of the large sites differs functionally from other rooms of the large sites. The interpretation of these findings has to be that at least seven functionally different categories of rooms were excavated in Vosberg Valley. The problem is that it would be difficult even to define seven functionally different categories of prehistoric rooms let alone to accept that each of these kinds actually existed in Vosberg Valley, and further that, by chance, excavations in the valley of a relatively small number of rooms happened to have taken place in just those functionally different rooms. The unusual outcome to the chi-square comparisons immediately and strongly suggests problems with the data itself. One might conclude that materials associated with rooms cannot be used as reliable indicators of room function, but it seems much more likely that it is not valid, as was done in the case of Vosberg Valley, to use all materials within a room, as opposed to floor associations, in determining functional comparability. A substantial amount of material can be introduced into a room space after abandonment through washing in of some items and intentional deposition of trash.

In addition to its use in the foregoing chi-square tests, ceramic data can also be used in another way to assess functional comparability between rooms. If the rooms being compared, with the possible exception of Feature 1 at AZ P:13:26B, functioned in the same manner, one might expect the ratio of ceramic bowls to jars in each to be approximately the same. To test this, rim sherds from each room were first separated into the categories of bowls, jars, plates, and those too fragmentary to classify. Counts were then tallied, and the bowl-to-jar ratio was calculated for each room by dividing the bowl count by the jar count. To facilitate conceptualization, the frequency of jars in each case was assigned a value of one and a proportional bowl frequency was calculated. This data is given in table 8 in which two things are readily apparent. First, bowl rim sherds far outnumber those from jars in each of the rooms. Second, the ratio for AZ P:13:19, Feature 1, contrasts markedly with that of the other rooms, so markedly in fact that

Table 8

BOWL-JAR RATIOS FOR INDIVIDUAL ROOM UNITS

Site	Feature	Bowls	Jars	Plates	Unidentified	Bowl:Jar
P:13:19	1	19	2	2	2	9.5:1
P:13:26A	1	73	59	1	28	1.2:1
P:13:26A	2	86	38	2	87	2.3:1
P:13:26A	5	150	43	2	37	3.5:1
P:13:26B	1	23	21	0	3	1.1:1
P:13:26B	2	46	39	3	12	1.2:1
P:13:10	3	129	45	0	110	2.9:1
P:13:10	4	56	26	0	23	2.1:1
P:13:10	7	104	33	0	17	3.1:1
P:13:10	10	278	100	3	108	2.8:1
P:13:10	11	395	200	7	179	2.0:1

there seems little need to test for statistical significance of this difference. Even keeping in mind that this ratio is based upon the smallest number of rim sherds from any room, it does, nevertheless, argue against expectations based upon the presumption of functional equivalence between rooms at large and small sites.

Adjusted bowl frequencies for the other rooms vary from 1.1 to 3.5 with no discernible pattern. If rim sherd counts are pooled to give an average ratio for entire sites instead of individual rooms, AZ P:13:26 and AZ P:13:10 provide fairly similar values of 1.9 and 2.4, respectively. Interestingly, the bowl-jar ratio for the probable ceremonial room, Feature 1 of AZ P:13:26B, is so close to that from some of the other rooms that it again precludes the necessity of testing for statistical significance. This information argues against the expectation that functional differences are reflected in bowl-jar ratios. In all of the above ratio comparisons, it should be kept in mind that this data is subject to the same problems found in the previous chi-square comparisons.

There is yet another means of assessing functional similarity between rooms through comparisons of associated material. It has been mentioned that numerical frequencies for materials from rooms at AZ P:13:7 and AZ P:13:29 could not be obtained, but qualitative data are available from these sites in terms of the presence of various categories of material. Field notes from AZ P:13:7 record the presence of manos, metates, pot sherds, worked sherds, polishing stones, bone awls, spindle whorls, hammer stones, lithic debitage, projectile points, knives, utilized flakes, figurines, worked steatite, steatite rings, steatite pendants, axes, and deer bone; and those from AZ P:13:29 record the presence of manos, metates, pottery sherds, polishing stones, bone awls, hammer stones, cores, flakes, projectile points, utilized flakes, worked steatite, clay coils, serpentine beads, choppers, and unidentified animal bone. Thus, the kinds of material present at both sites include items representative of each of the seven functional categories established in table 5. Every room excavated in Vosberg Valley contained artifacts and debris indicative of the same range of activities including food preparation, food serving, hunting, tool manufacturing, day-to-day household chores, and ritual involvement. On this basis, the notion of functional equivalence between rooms is supported.

Finally, it was suggested under Test Implication IB that economic pollen data should indicate year-round occupation of large and small sites alike. Unfortunately, analysis has shown that pollen grains from economic species do not occur in sufficient quantity to make such a determination (Rankin, personal communication). However, noneconomic pollen grains analyzed from both large and small sites are not distinguishable in either the variety of taxa represented or the relative representation of each; and, according to Schoenwetter (personal communication), this shows a lack of the sort of distinctions which might be expected in cases of difference in seasonal occupation. The number of pollen samples collected during excavation allowed analysis to be restricted to those samples which most probably represent horizons of occupancy in each room.

Recalling that, with the exception of internal pit features, analysis undertaken for Test Implication IA indicated no difference among all rooms of large and small sites with regard to structure attributes, the results of Test Implication IB can now be summarized and added to this finding. Quantitative comparisons of material grouped into functional categories demonstrated a lack of functional equivalence between most of the limited number of rooms for which such a comparison was possible, but led to serious questions concerning the usefulness of the data in arriving at such a conclusion. Bowl-jar ratio comparisons showed a strong dichotomy between a single room at one small site and ten rooms at two large sites. On a presence-absence level, all excavated rooms produced materials representative of a full range of activities. Quantities of economic pollen grains were insufficient for determinations of seasonality, but noneconomic pollen recovered suggested no difference in the seasonal occupation of large and small sites.

It is evident that the results of most of the preceding tests support the position that rooms at large and small sites were functionally comparable; but another, though lesser, portion indicates the opposite; and still another portion suggests no clearcut conclusion because of the questionable nature of the data used. One would hope for complete support of the hypothesis in all relevant tests, but this has not been the case. The fact that some of the tests do not support the hypothesis suggests the possibility that the analysis may be suffering from an initial over-simplification of the problem. It was postulated that variability in the archeological record at Vosberg could be attributed to <u>either</u> temporal differences <u>or</u>

functional differences, but perhaps the problem is more complex than this simple either-or dichotomy. The possibility exists that temporal as well as functional variability have left their stamp on the archeological record. It is my feeling that an acceptable case has been made supporting the contention that rooms of large and small sites were functionally equivalent, but that partially conflicting results can be attributed to complications introduced by temporal variability in the archeological record. However, resolution of this problem must await a future situation in which greater control of the data available for quantitative analysis is possible.

Test Implication IC states that room size in Vosberg Valley should compare favorably with size dimensions of structures in other areas known to have housed nuclear family-sized units. Archeologists generally derive inferences about prehistoric social units from quantitative approximations of the amount of floor space required by a given number of people. One such equation is offered by Cook (1972) who gathered data on floor space requirements of both nuclear and extended family units from numerous ethnographic and archeological sources. He determined that a reasonably upper-limit cutoff for floor space requirements of nuclear family units is 46.45 $m.^2$ and that houses with more floor space than this were almost invariably occupied by two or more families, i.e., extended families.

Table 9 offers a comparison of floor space figures from Vosberg Valley with those compiled by Cook (1972:table 1) using a sample of several thousand nuclear family-sized structures located in different parts of North America. Rooms in Vosberg Valley all fall easily into the range, 11.10 $m.^2$ to 33.16 $m.^2$, of room sizes recorded by Cook; and, because Cook's article includes metric data, it is also possible to make a statistically based comparison between his data and that from Vosberg Valley. Treating each separate mean value presented by Cook as a single floor area value, an overall mean was calculated (actually a mean of means). Mean floor area for Vosberg's rooms and Cook's data were then compared using a difference-of-means test (see Blalock 1972:220-228). The null hypothesis tested states that there is no significant difference between the mean values of the two samples at a significance level of 0.05. A t value of 0.49 was derived with 26 degrees of freedom. Using a t table, it was found that the null hypothesis could not be rejected at the chosen level of significance; and it is therefore concluded that no significant difference exists between

Table 9

COMPARISON OF ROOM FLOOR AREA: VOSBERG VALLEY VS. NUCLEAR FAMILY-SIZED STRUCTURES IN OTHER REGIONS

Vosberg Rooms			Nuclear Family Structures Elsewhere	
Site and	Feature	Floor Area--m^2	General Locus	Floor Area--m^2
P:13:7	F. 1	22.79	California	11.10
P:13:7	F. 2	24.00	New Mexico	11.89
P:13:19	F. 1	15.81	Alaska	11.89
P:13:29	F. 2	22.00	New Mexico	12.36
P:13:29	F. 6	15.16	New Mexico	14.40
P:13:10	F. 3	20.80	Utah	15.98
P:13:10	F. 4	24.30	Northern Plains	20.44
P:13:10	F. 7	19.50	Colorado	20.90
P:13:10	F. 10	18.00	Arizona	22.57
P:13:10	F. 11	22.20	New Mexico	23.50
P:13:26A	F. 1	24.00	New Mexico	25.92
P:13:26A	F. 2	22.80	Arizona	29.33
P:13:26A	F. 5	30.00	Arizona	33.16
P:13:26B	F. 2	16.90	Alaska	29.91
		$\bar{x}$ = 21.30		$\bar{x}$ = 20.18
		o = 4.01		o = 7.11

$\underline{t}$ = 0.49

d.f. = 26

Significance level = 0.05

Cook's floor area values and those from Vosberg Valley, supporting Test Implication IC. Since Cook's data were derived from nuclear family habitation structures, it is reasonable to argue by analogy that the sample of excavated rooms in Vosberg Valley were also built to accommodate social units of nuclear family size.

It can be further argued on the basis of preceding analyses that the occupant social unit in all rooms, with the exception of the possible ceremonial room at AZ P:13:26B, was not only the size of the nuclear family but was indeed the nuclear family. It has been established as a result of the comparison in table 3 that there is no significant difference in the size of rooms at large and small sites, suggesting a lack of functional difference. One would expect limited activities to be reflected in a limited range of artifact and debris categories, but a functional categorization of materials present in all room structures indicated a range of both male and female activities, as would be expected if families have been the occupant groups.

The preceding analyses have examined the question of functional comparability between rooms of large and small sites from a number of aspects. The outcome of these analyses are briefly recapitulated below.

A comparison of room construction attributes disclosed a number of correspondences between rooms of large and small sites, but also a single instance of noncomparability; rooms of large sites contained more pits and larger pits than rooms of small sites. In those cases where data was available, rooms were then compared in terms of quantities of items in seven functional categories of artifacts from all provenience units within the limits of each room. The analysis indicated that seven out of eight rooms compared were all functionally different from one another; this conclusion was rejected as extremely unlikely, perhaps due to the unsatisfactory nature of the data employed in making the comparisons. A presence-absence comparison of materials in the same seven functional categories indicated that a full range of comparable activities were carried out in all rooms at sites of both sizes. Pollen analysis indicated comparability in the seasonal occupation of both categories of rooms, while a bowl-to-jar ratio comparison showed a single room at one small site to be markedly different from ten rooms at two large sites. In the last analytical procedure, Vosberg room floor areas were compared to room floor areas from a sample

of several thousand rooms reported to have housed nuclear family social units; no significant difference was found.

In summary, of the preceding analyses which yielded reasonable results, most indicate functional comparability between rooms of large and small sites in Vosberg Valley. The differences noted in pit capacity and bowl-to-jar ratios are not considered sufficient evidence to refute this. It is further suggested, although not demonstrated, that all rooms compared probably housed nuclear family units.

Demography: A Diachronic Perspective

The major hypothesis under investigation posits increasing population as one of the factors in a causal nexus leading to changing co-residence patterns in Vosberg Valley. In this section, sites having surface indications of rectangular, boulder-cobble outlined rooms characteristic of the A.D. 1050 to 1250 period are seriated to obtain chronological control. Then room counts, considered in a temporal series, are used to establish a population curve showing relative changes in population through the period. Room count figures are finally converted to "absolute" population figures based upon probable numbers of persons in occupancy per unit of floor area.

Survey in Vosberg Valley resulted in the recording of 87 sites representing the ten time periods established by Chenhall (1972). Both single and multi-component sites were located, ranging from small sherd and lithic scatters, to agricultural sites, to large and small, multi-roomed habitations. At least 63 (72 percent) of the 87 sites date in, or have components which date in, the A.D. 1050 to 1250 period; thus, on the basis of site numbers alone, this period is clearly the time of major occupation in the valley. Since the focus of attention here is on changing co-residence patterns, the present analysis deals only with habitation sites of the A.D. 1050 to 1250 period and excludes sherd and lithic scatters. Agricultural sites also play a part in the analysis, but they are considered in a later section of the paper.

Descriptive data on the 61 sites recorded through 1969 were tabulated by Chenhall (1972:75-80). In 1974, the original 61 sites were revisited, reevaluated, and in some instances recollected by the author. During

the process of resurvey, 26 new sites were located and added to the Vosberg roster. Descriptive data and probable dates for all 87 sites are given in table 10. Comparison of this table with table 8 in Chenhall (1972:75-80) discloses that descriptive characterizations of sites common to both tables do not always agree, particularly regarding room counts; but, based upon personal observation of surface remains, some descriptive changes were deemed necessary. The main difference between previous field assessments and the present one is that in the present one room counts were purposely biased in a conservative direction in that surface evidence for room structures had to be sufficiently evident before a site was recorded as a habitation site. Probably in this process some sites with scant evidence of domiciliary architecture were recorded as sherd and lithic scatters, and population figures derived from room counts are thus biased downward. However, this should compensate to some degree for population over-estimation due to the necessary but erroneous assumption that all rooms at any given site were occupied contemporaneously.

Out of the 63 sites dating in the A. D. 1050 to 1250 period, 48 had surface evidence of room structures. Surface ceramics were used to seriate these sites, but six of the 48 could not be included in this procedure. Four of the six excluded sites, AZ P:13:7, AZ P:13:18, AZ P:13:29, and AZ P:13:82, are multi-component sites for which no effective separation of ceramics from different components could be made; and, even though two of them have been excavated, subsurface ceramic data could not be substituted for surface data for seriation purposes because this data was not available for quantification. Two other excluded sites, AZ P:13:56 and AZ P:13:85, produced too few surface sherds to yield a reliable seriation.

Site seriation was accomplished using relative proportions of three ceramic types and the triangular graph technique (Meighan 1959). In this technique, the total number of sherds for each of any three numerically sufficient ceramic types is made equal to 100 percent for each site to be seriated, and the proportion of each type is then calculated for each site and converted to a percentage. When these relative percentages are plotted on triangular graph paper, each site is defined by a single point; and, if one is attempting to seriate a valid series of objects, the points will form a rough linear scatter on the graph. A seriation line is then drawn such that it separates

Table 10

ARCHEOLOGICAL SITES IN VOSBERG VALLEY

Site AZ P:13:-	Unit	Date A.D.	Description
1		900-1000	5+ pit houses and 1 ceremonial room
7	A	900-1000	2+ pit houses and 1 ceremonial room
	B	1050-1250	4+ stone-outlined rooms (2 contiguous)
10	A	900-1000	5 pit houses
	B	1050-1250	8 stone-outlined rooms (7 contiguous)
	C	1050-1250	Agricultural system, type C
11		1050-1250	5 stone-outlined rooms (all contiguous)
12		1850-pres.	Historic site, Flying-V Ranch
13		1300-1400	Pueblo, 40+ masonry rooms
15	A	Pre-1000	Pit houses (?)
	B	900-1250	Sherd and lithic scatter
	C	Pre-1000	Check dam
16		900-1000	Sherd and lithic scatter
17		700-800	2 pit houses
18	A	750-900	? pit houses
	B	1050-1250	2 stone-outlined rooms (contiguous)
19		1050-1250	2 stone-outlined rooms (contiguous)
20		900-1000	2 (?) pit houses
21		900-1000	Sherd and lithic scatter
26	A	1050-1250	16+ stone-outlined rooms (contiguous blocks of 3, 5, 4 & 4 rooms each)
	B	1050-1250	11 stone-outlined rooms (contiguous blocks of 4 and 6 rooms each, 1 room separate)

Table 10--Continued

Site AZ P:13:-	Unit	Date A.D.	Description
27		Pre-700	Non-ceramic camp site
28		1050-1250	Agricultural system, type B (diversion wall)
29	A	750-900	4 pit houses
	B	1050-1250	2 stone-outlined rooms (noncontiguous)
	C	1050-1250	Agricultural system, type C
30		1050-1250	1 stone-outlined room
31		750-900	Sherd and lithic scatter (pit houses ?)
32		1050-1250	2 stone-outlined rooms (noncontiguous)
33	A	1050-1250	5 stone-outlined rooms (2 contiguous)
	B	1050-1250	Agricultural system, type C
34		1050-1250	27 stone-outlined rooms (contiguous blocks of 12 and 15 rooms each)
36	A	1050-1250	5 stone-outlined rooms (contiguous blocks of 2 and 3 rooms each)
	B	1050-1250	Sherd and lithic scatter
37		900-1000	? pit houses
38		900-1000	? pit houses
39	A	750-900	? pit houses
	B	1050-1250	4 stone-outlined rooms (all contiguous)
	C	1050-1250	Agricultural system, type C
40		1050-1250	Sherd and lithic scatter
41		1050-1250	2 stone-outlined rooms (contiguous)
42		1050-1250	Sherd and lithic scatter

Table 10--Continued

Site AZ P:13:-	Unit	Date A.D.	Description
43	A	1050-1250	Food preparation area--ovens
	B	1050-1250	Agricultural system, type C
44		1050-1250	Sherd and lithic scatter
45		750-900	Sherd and lithic scatter
46		1050-1250	3 stone-outlined rooms (all contiguous)
47	A	1050-1250	Agricultural system, type C (D)
	B	1050-1250	Agricultural system, type A
48		900-1000	5-6 pit houses
49		1850-pres.	Historic site, log cabin & out-building
50	A	1050-1250	2 stone-outlined rooms (contiguous)
	B	1050-1250	Sherd and lithic scatter
51	A	1050-1250	3 stone-outlined rooms (all contiguous)
	B	1050-1250	Agricultural system, type A
52		1850-pres.	Athabascan camp site
53	A	1050-1250	13+ stone-outlined rooms (a few contiguous, most are scattered)
	B	1050-1250	Agricultural system, type A
54		1050-1250	Sherd and lithic scatter
55		1050-1250	2 stone-outlined rooms (contiguous)
56		1050-1250	2 stone-outlined rooms (contiguous)
57	A	1050-1250	2 stone-outlined rooms (contiguous)
	B	1050-1250	Agricultural system, type A
58		1050-1250	4 stone-outlined rooms (3 contiguous)

Table 10--Continued

Site AZ P:13:-	Unit	Date A.D.	Description
59	A	1050-1250	(?) jacal structures, no stone outlines seen--count of discreet scatters yields about 15 rooms
	B	1050-1250	Agricultural system, type A
60		900-1000	? pit houses
61		1050-1250	3 stone-outlined rooms (2 contiguous)
62		750-900	? pit houses
63		1050-1250	2 stone-outlined rooms (noncontiguous)
64		? ?	Sherd and lithic scatter
65		1050-1250	Sherd and lithic scatter
66		1050-1250	2 stone-outlined rooms (contiguous)
67		1050-1250	2 stone-outlined rooms (contiguous)
68		1050-1250	20 stone-outlined rooms (some contiguous, some scattered)
69		1050-1250	Sherd and lithic scatter
70		900-1000	? pit houses
71		1050-1250	5 stone-outlined rooms (all contiguous)
72		1050-1250	Agricultural system, type C
73		1050-1250	1 stone-outlined room
74		1050-1250?	Agricultural system, large and complex, type not determined
79		1050-1250	3 stone-outlined rooms (all contiguous)

Table 10--Continued

Site AZ P:13:-	Unit	Date A.D.	Description
80		1050-1250	5 stone-outlined rooms (all contiguous)
81		1050-1250	2 stone-outlined rooms (contiguous)
82	A	900-1000	12-15 pit houses
	B	1050-1250	3 stone-outlined rooms (2 contiguous)
83		? ?	Check dam
84		1050-1250	Sherd and lithic scatter
85		1050-1250	2 stone-outlined rooms (contiguous)
86		1050-1250	Sherd and lithic scatter
87		1050-1250	2 stone-outlined rooms (contiguous)
88	A	1050-1250	3 stone-outlined rooms (all contiguous)
	B	1050-1250	Agricultural system, type C
89		1050-1250	5 stone-outlined rooms (all contiguous)
90		? ?	Series of 3 or more large check dams
91		1050-1250	8 stone-outlined rooms (all noncontiguous)
92		1050-1250	2 stone-outlined rooms (contiguous)
93		1050-1250	1 stone-outlined room
94		1050-1250	3 stone-outlined rooms (all contiguous)
95		1050-1250?	Sherd and lithic scatter
96		900-1000	? pit houses
97		1050-1250	4 stone-outlined rooms (all contiguous)

Table 10--Continued

Site AZ P:13:-	Unit	Date A.D.	Description
98		1050-1250	2 stone-outlined rooms (contiguous)
99		900-1000	? pit houses
100		1050-1250	1 stone-outlined room
101		1050-1250	Sherd and lithic scatter
102	A	1050-1250	2 stone-outlined rooms (contiguous)
	B	? ?	Sherd and lithic scatter
103	A	1050-1250	2 stone-outlined rooms (noncontiguous)
	B	1050-1250	Check dam
104		1050-1250	2 stone-outlined rooms (noncontiguous)

the points into two groups. If the plotted points are scattered widely and irregularly over the graph, it indicates that one is trying to seriate objects which do not really pertain to a single series. The location of each point along the seriation line, determined by a perpendicular line drawn from each point to the seriation line, defines the position of each site in the series.

For seriation of Vosberg Valley sites, the ceramic types used were Vosberg Brown, Vosberg Corrugated (plates XXVIII-XXXI), and Salado Red; Vosberg Variety (plates XXXII-XXXV). These types were chosen because they are, by far, the most abundant ceramics at all sites. Tree-ring dated, painted types could not be used for the finely graded seriation required by the problem at hand. It was mentioned previously that probably no painted, decorated ceramic type is indigeneous to Vosberg Valley; all such ceramics found here are of types known to have other areas of origin, mainly to the north and east of the valley area. None of them are tempered with local tempering material, and all occur in such low frequencies that Vosberg Valley itself seems an unlikely source of manufacture. Although an effort was made during survey to collect all painted, decorated wares on any given site's surface, such ceramics were completely absent from some sites and rare on others; but, even in cases where a reasonably large amount of painted, decorated pottery was collected, there was difficulty involving simple recognition of named black-on-white types.

Black-on-white types recognized by Chenhall (1972) in Vosberg ceramic collections pertaining to the A. D. 1050 to 1250 period include Black Mesa Black-on-white, Red Mesa Black-on-white, Reserve Black-on-white, Snowflake Black-on-white, Gallup Black-on-white, Puerco Black-on-white, and Tularosa Black-on-white. However, Simonis (n. d.) studied the black-on-white pottery from excavation of AZ P:13:10 in detail and found that a single type, Snowflake Black-on-white, accounted for as much as 75 to 85 percent of the black-on-white pottery from the site. My analysis suggests that such high percentages pertain to other Vosberg sites as well. Snowflake Black-on-white is a veritable "catch-all" category for black-on-white ceramics made in east-central Arizona; and that from Vosberg Valley sites often has a Snowflake type paste but is painted with design styles common to other types such as Kiatuthlana Black-on-white, Red Mesa Black-on-white, and Black Mesa Black-on-white (Chenhall 1972). This confusing situation is

further complicated by broad, inclusive dates for Snowflake Black-on-white. Based on dates given by Longacre (1964b) and Tuggle (1970), Chenhall derived a date range from A.D. 950 to 1200 for Snowflake Black-on-white. These problems make black-on-white ceramics from Vosberg Valley a poor tool for establishing a finely graded chronology.

However, once the appropriate ceramic types have been selected, a further problem with the triangular graph seriation technique is that, after a seriation line is plotted, there is no indication of which end of the line is early and which is late; this must be established using some independent chronological marker. Painted, decorated ceramics from Vosberg Valley other than black-on-white types include Pinto and Gila Polychrome (plates XXXVI and XXXVII), a few White Mountain Redware types, particularly the polychromes, and others such as Salado White-on-red and McDonald Painted Corrugated. In the following seriation, the above polychrome types can serve as independent chronological markers because their inclusive dates generally begin in the latter part of the A.D. 1050 to 1250 period (see Breternitz 1966; Carlson 1970).

Sherd counts for Vosberg Brown, Vosberg Corrugated, and Salado Red; Vosberg Variety have been listed for 42 sites and converted to percentages in table 11. These percentages were then plotted on triangular graph paper in figure 8, and a seriation line was drawn. Reference to table 10 gives the numbers of rooms for each of the seriated sites. Room counts per site were then plotted against time to produce the histogram in figure 9. The histogram also indicates the presence of relatively late polychrome types by placement of the letter "P" above the frequency bar for those sites at which polychrome ceramics were collected. Since these polychromes generally occur at sites toward the right-hand side of the sequence, the temporal arrow has been placed in that direction.

Clearly, figure 9 shows that small sites occur generally toward the early end of the sequence while large sites occur toward the late end. It is also very evident that population numbers, indicated through room counts, increase markedly through the period, thus supporting Secondary Hypothesis II which postulated significant population increase during the A.D. 1050 to 1250 period.

Table 11

SHERD FREQUENCIES USED IN SITE SERIATION

Site	Vosberg Brown		Salado Red; Vosberg Variety		Vosberg Corrugated	
AZ P:13:-	Count	%	Count	%	Count	%
10*	2322	8.61	8293	30.74	16360	60.65
11	6	4.84	41	33.06	77	62.10
19*	128	10.65	275	22.89	799	66.47
26	19	4.80	159	40.56	214	54.59
30	155	74.16	4	1.91	50	23.92
32	74	61.16	4	3.30	43	35.54
33	24	15.89	32	21.19	95	62.91
34	12	6.94	50	28.90	111	64.16
36	74	63.79	2	1.72	40	34.49
39	54	63.42	6	7.32	22	29.27
41	94	84.68	6	5.40	11	9.91
46	56	50.91	10	9.09	44	40.01
50	107	89.17	0	0.00	13	10.83
51	13	8.33	46	29.49	97	62.18
53	61	34.66	26	14.77	89	50.57
55	122	67.78	5	2.78	53	29.44
57	339	86.26	11	2.80	43	10.94
58	5	4.85	11	10.68	87	84.47
59	48	20.60	29	12.45	156	66.95
61	86	90.53	1	1.05	8	8.42
63	84	76.36	1	0.91	25	22.73
66	61	78.20	3	3.85	14	17.95
67	24	16.00	29	19.33	97	64.67
68	22	14.76	5	3.36	122	81.88
71	14	13.73	17	16.67	71	69.61
73	15	15.79	30	31.58	50	52.63
79	13	10.00	41	31.54	76	58.47
80	2	3.23	28	30.11	62	66.65
81	11	14.28	22	28.57	44	57.14
87	35	30.43	35	30.43	45	39.14
88	60	96.77	2	3.22	0	0.00
89	3	3.33	17	19.89	70	77.79

Table 11--Continued

Site	Vosberg Brown		Salado Red; Vosberg Variety		Vosberg Corrugated	
AZ P:13:-	Count	%	Count	%	Count	%
91	34	42.50	17	21.25	29	36.25
92	86	90.52	0	0.00	9	9.47
93	107	100.00	0	0.00	0	0.00
94	93	94.89	1	1.02	4	4.08
97	48	45.72	11	10.47	46	43.81
98	94	78.33	15	12.50	11	9.17
100	58	87.88	0	0.00	8	12.12
102	37	64.66	0	0.00	24	35.34
103	9	14.52	21	33.87	32	51.61
104	75	100.00	0	0.00	0	0.00

*Count based on excavated sherds.

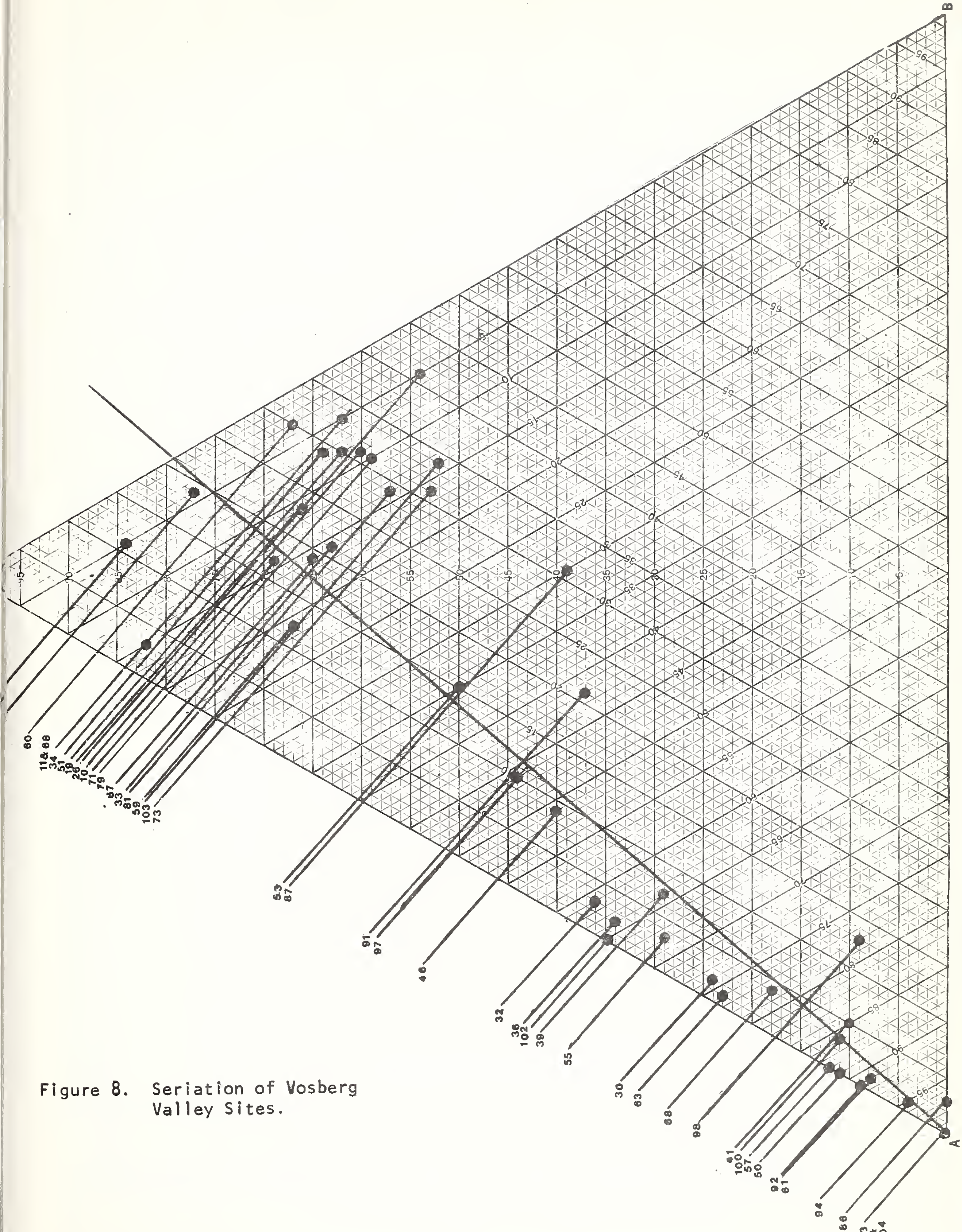


Figure 8. Seriation of Vosberg Valley Sites.

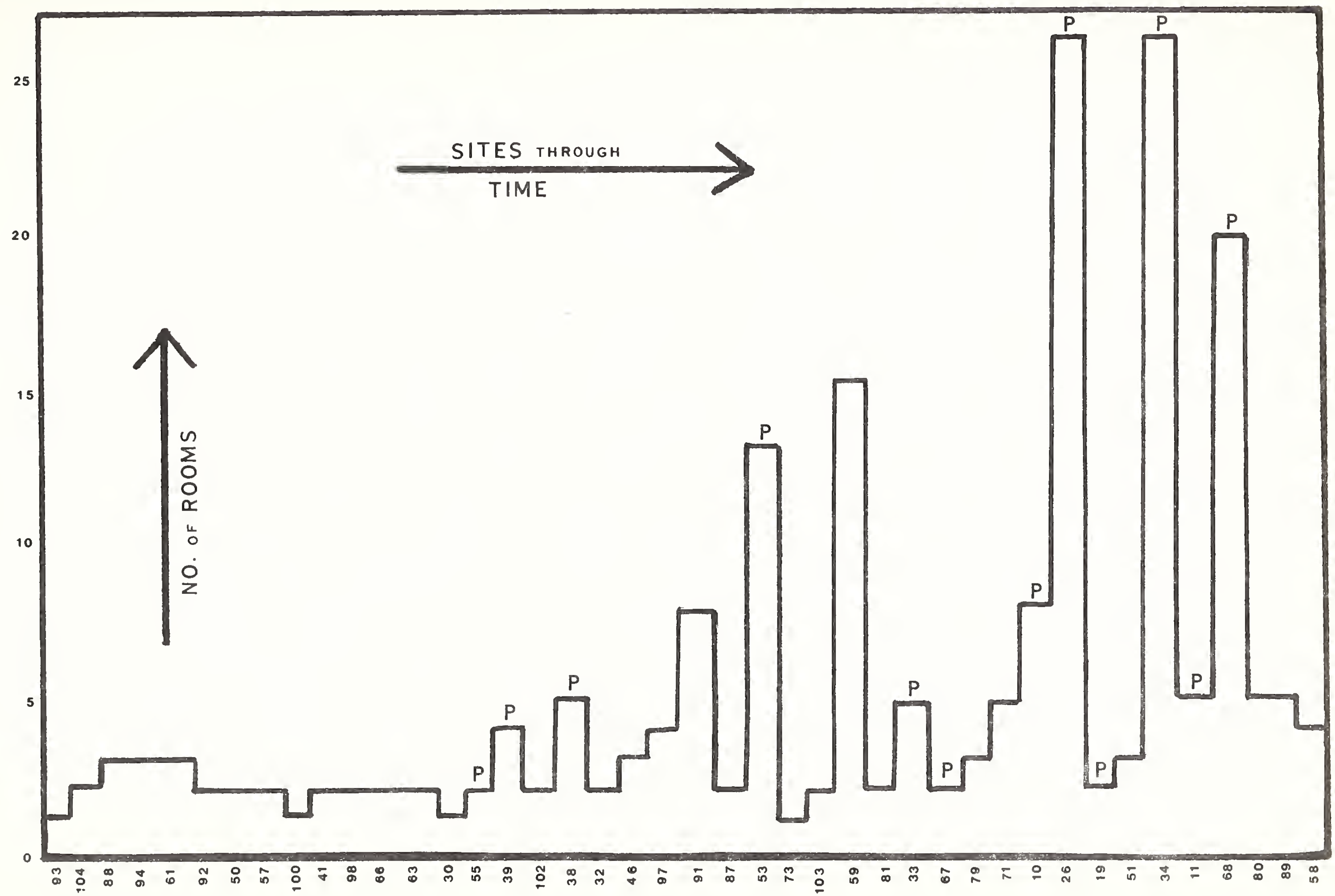


Figure 9. Sites series showing room counts

For purposes of illustration, the data contained in the histogram of figure 9 can be rendered as a smooth curve. To accomplish this, the sequence of 42 sites was broken down into four equal units of 10.5 sites each, labeled I, II, III, and IV; i.e., moving from left to right along the horizontal axis, the first 10.5 sites form a group (I), the next 10.5 sites form the next group (II), etc. Room counts were then combined for each of these sequential units. The first group of 10.5 sites has a total of 22 rooms; the second has a total of 28 rooms; the third has a total of 58 rooms; and the fourth has a total of 108 rooms. Combined room counts for the four units are plotted against time in figure 10. Actually, the total room count for the valley during the A.D. 1050 to 1250 period should be increased by 16 to include rooms of the 6 sites not seriated; but, since it is not known how the 16 rooms are distributed through the series, they have not been included. The plotted increase in number of rooms through time takes the form of an exponential curve; and, if one posits that room counts are directly proportional to the numbers of persons inhabiting rooms, the population curve is coincident with that for increasing room counts.

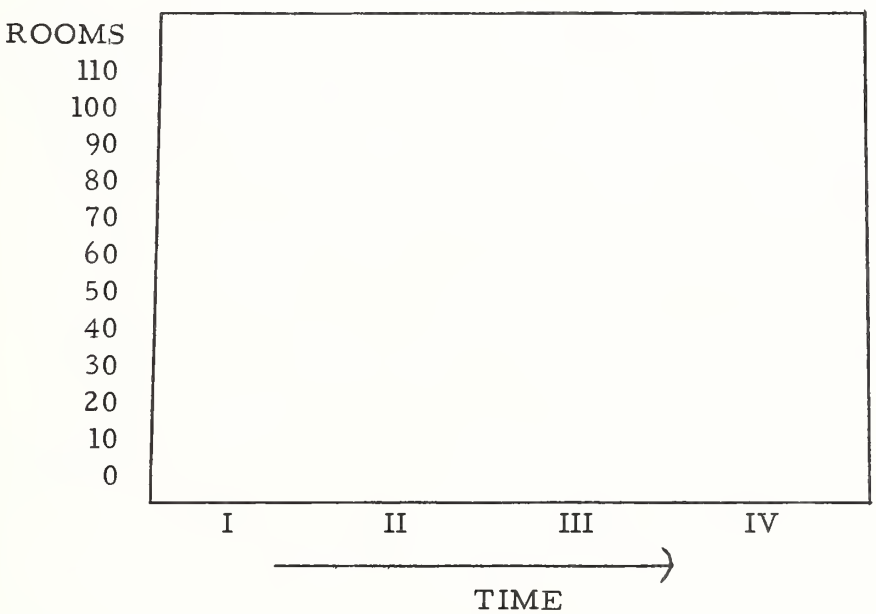


Figure 10. Combined room counts through time.

It is also possible to transform the sequential room counts into "absolute" population figures. According to Cook (1972:13), ". . . , estimates of household and family size derived from modern or historical floor space measurements can be projected with confidence backward to the archeological epoch." Consulting several sources but relying heavily on data compiled by Turner and Lofgren (1966), Cook (1972:15) arrived at a central value of 5.0 persons for the size of the nuclear family in the ethnographic Southwest. It has been argued previously that boulder-cobble outlined rooms in Vosberg Valley were built to accommodate nuclear family-sized social units. Using combined room counts from the four illustrative time units established above, it is a simple matter to multiply each figure by five to derive numbers of persons per temporal unit (table 12). Since the total time involved is about 200 years in duration, one can think of each of the four units as 50 year sub-units, but it is not suggested that this is an entirely valid method of dividing up the Vosberg Valley sequence. Equating each sub-unit with a 50-year span is meant principally as a visual aid for presenting differences in "absolute" population numbers through the period. Table 12 yields a surprising result for sub-period IV in that population numbers were calculated at 540 persons for this roughly 50-year span. Since Vosberg Valley is relatively small with no particularly abundant resources, this figure seems excessive. No doubt the assumption of occupational contemporaneity for all rooms at each site contributes to the apparently inflated figure, but just how much distortion is caused by this assumption is a very pressing problem in prehistoric population studies for which no solution has yet been reached.

Table 12

VOSBERG POPULATION NUMBERS THROUGH TIME

Unit	I	II	III	IV
Rooms	22	28	58	108
Persons	110	140	280	540

Another pattern of archeological interest is evident in the histogram of figure 9. Large sites are generally late in the sequence with a few

small sites persisting throughout the period. However, there is a tendency for "small" sites late in the period to be larger than "small" sites early in the period. Nevertheless, it is apparent that the change from a pattern of small, dispersed sites to one of aggregated sites did not occur all at once. By the middle of the sequence, some large sites have appeared, but part of the populace continued to live at small sites. Archeologically, it is necessary that we be able to discern change of this kind in settlement patterns if we hope to conduct effective processual studies. As a general rule, archeologists tend to think and classify in terms of relatively large blocks of time. Insofar as this facilitates communication between archeologists, it is an acceptable modus operandi. However, the many and varied traits relevant to such a block of time are usually distilled down to a few normatively derived traits which are said to characterize the entire period, a period which may be several hundred years in duration. The preceding and succeeding periods are also said to be characterized by similarly derived trait configurations. As a result, the conceptually established boundaries between sequential periods take on an appearance of relatively brief time spans of rapid change. For example, in a hypothetical case, one might say, "There was a pattern of dispersed settlement during the period from A.D. 800 to 1000, but from A.D. 1000 to 1200 settlements were aggregated." We are left with the impression that something caused a change in settlement patterns right around A.D. 1000. Settlement patterns in Vosberg Valley during the entire A.D. 1050 to 1250 period could be reduced to a single definitive dimension by simply citing the most frequently occurring site types as the characteristic one, but this would distort the actual nature of the situation as indicated in figure 9. Change is continuous and must be dealt with as such if we hope to explain occurrences in the past.

Perhaps one example of undesirable results stemming from archeologists' predilection for lumping prehistoric phenomena into macrocategories of time is the persistence of "a need for defense" as an "explanation" for population aggregation in the Southwest. That which appears to occur precipitously, though it may be nothing more than an artifact of classification, demands some sort of catastrophic explanation; and the necessity for defense against unknown invaders is a very appealing explanation for a "sudden" change from dispersed to aggregated settlements. This is not to

say that prehistoric peoples were never forced to move to a common location for mutual protection; they probably sometimes were. But archeologists should be wary of the possibility of attempting to explain "patterns" which never existed in the first place.

Contrary to the idea of sudden change stemming from some catastrophic event, it was predicted in Supportive Hypothesis I that settlement pattern change in Vosberg Valley was gradual, having resulted from incremental population increase. But the exponentially increasing population curve in figure 10 cannot be characterized as gradual, and the hypothesis is not supported. However, the histogram in figure 9 demonstrates change in co-residence did occur rather gradually; there are small sites dispersed throughout the sequence. Thus, despite rather dramatic population increase, there seems to have been no immediate change precipitated in co-residence patterns. Apparently a buffer of some kind intervened between the growing population and its mode of organization. In retrospect, this should have been anticipated since social organization is not a direct reflection of the number of persons participating in a social system. If it were, all populations of the same size would be organized in the same manner, which is demonstrably not the case.

Biophysical Environment and Agricultural Potential

This study assumes for purposes of argument that the principal intervening variable between population growth and social organizational change is to be found in the realm of subsistence practices. An expanding population must find ways to feed itself; and, once population begins to expand, customary subsistence resources, previously present in sufficient quantity, may become more and more scarce vis-a-vis the enlarged population. Because population growth alters the relationship between a resource and a consuming populace, any organizational principles which, at lower population levels, are tied to usage and control of resource should change accordingly if the society is to maintain its coherence. It is the author's position that agriculturally productive land was the resource around which co-residential change took place in Vosberg Valley. Thus it is necessary to examine intensively the factors surrounding and conditioning agriculture as practiced by the prehistoric people in the valley.

In accord with Test Implications A, B, C, and D of Secondary Hypothesis III, this section looks principally at four broad subdivisions of the biophysical environment (climate, topography, hydrography, and soils) in order to test the propositions that there was a range of agricultural capability in different parts of the valley and that good land was available in limited quantities. Together these four factors not only set limits for agriculture but should also interrelate to afford a setting in which one finds a variety of niches with differing agricultural potential. It is widely acknowledged by plant ecologists and botanists (e.g., Oosting 1956) that the effect of these factors, vis-a-vis plant life, is intensified in a mountainous situation, such as that of Vosberg Valley. An introductory, brief discussion of natural vegetation in Vosberg Valley illustrates this point and leads into analyses of the other four environmental factors.

Climate is investigated first as an overall factor important to prehistoric agricultural practices. This is followed by separate analyses of topography, hydrography, and soils in which each of these environmental dimensions is broken down into various subclasses reflecting differing agricultural potential. Subclasses within each dimension are then ranked with regard to agricultural potential from best to poorest. To provide a means of testing Secondary Hypothesis III, the three dimensions, each with its own ranked subclasses, are then combined to yield additional analytical units called land-capability classes (see Buckman and Brady 1969) which also are then ranked from best to poorest with respect to agricultural potential. Climate plays no direct role in the formation of land-capability classes but sets the conditions within which agriculture was practiced on plots of land with intrinsically different potential. Establishment of ranked land classes also allows a means of testing subsequent hypotheses dealing with predicted relationships between site locations and land with differing agricultural potential.

Local Vegetation

As a result of altitudinal variation, vegetation in the State of Arizona is unusually diverse. Based upon vegetational differences, Lowe (1964:15-82) recognized seven vertically arranged life zones within the State: Lower Sonoran, Upper Sonoran, Transition, Canadian, Hudsonian, Arctic-Alpine, and Boreal. He further defined a number of subdivisions for these life zones. Vegetation in Vosberg Valley is also highly varied and includes plants which are representative

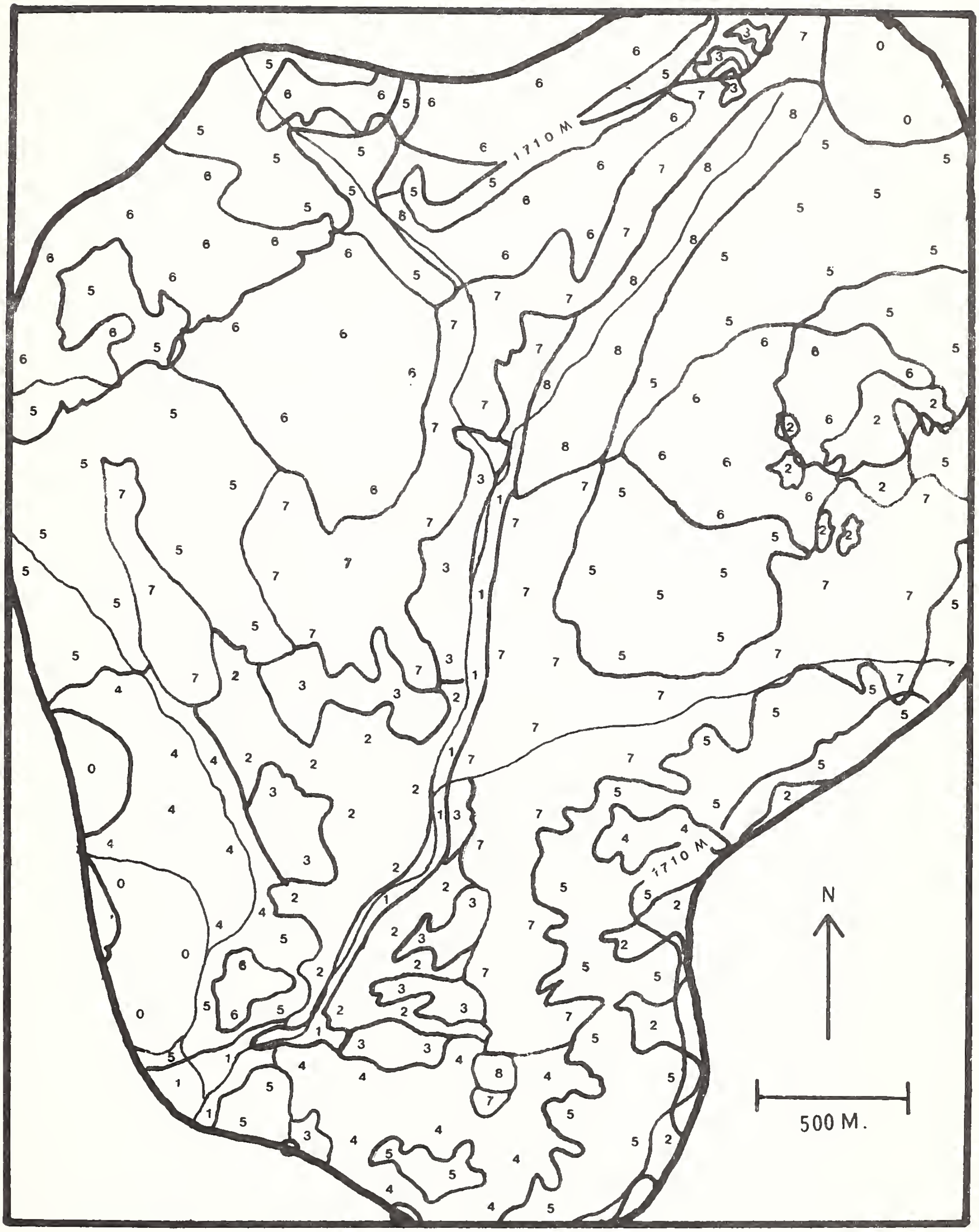
of grassland, chaparral, and woodland (both evergreen and riparian) subdivisions of the Upper Sonoran life zone and ponderosa pine forest of the Transition life zone. Although a few areas in the valley have grassland consociations and one area has a ponderosa pine consociation, most of the valley is characterized by mixed grassland, chaparral, woodland, and pine forest associations. No precise quantitative vegetation study has been conducted in the valley; but, impressionistically, it appears that chaparral, including scrub oak, manzanita, cat claw, and Apache plume, is numerically dominant followed closely by woodland trees including juniper, pinyon, and oak.

A listing of the more prevalent plant species in Vosberg Valley is available to the interested reader in Chenhall's work (1972:23-28), but my goal here is merely to point out that vegetation patterns in the valley form a complex mosaic. This is illustrated in the vegetation map of figure 11, adapted from one prepared by Chenhall (1972: map 6). Such complexity in vegetation patterning is, in large part, a response to a causal network of physical environmental factors which affect plant growth and survival. As plant ecologist Billings (1970:41) has noted,

> The assembling of individuals of various plant species into a plant community is the result of the total environment working through time on the available flora. As a result, vegetation is a delicate integrator of environmental conditions and can be used as an indicator of such conditions.

In a mountainous valley such as Vosberg, there is great diversity in topographic, hydrographic, and edaphic conditions from one small area to the next. In conjunction with climate and altitude, the factors of slope angle, slope-facing, water availability, and soil composition each contribute to complexity in vegetation patterns. Parameters important to natural vegetation are similarly important to the growth of cultivated plants, and they provided the physical environmental framework within which the prehistoric peoples of Vosberg Valley, who were basically agriculturalists, sought to earn their livelihood.

The relationship between prehistoric agricultural practices and several physical environmental factors is explored in greater detail in the following subsections.



Adapted from Chenhall 1972: Map 6.
Figure 11. Vegetation associations in Vosberg Valley.
(Key on following page)

Key to Figure 11

0 - Not classified.
1 - Riparian canopy and understory.
2 - Grassland.
3 - Scattered pinyon-oak-juniper with shrub and grassland understory.
4 - Pinyon-oak-juniper woodland with shrub understory.
5 - Pinyon-oak-juniper woodland with moderately dense manzanita-shrub live oak-cat claw.
6 - Pinyon-oak-juniper woodland with dense manzanita-shrub live oak-cat claw.
7 - Ecotone between ponderosa pine forest and pinyon-oak-juniper woodland with shrub and grassland understory.
8 - Ponderosa forest.

Climate and Agricultural Potential

Generally speaking, archeological literature shows a curious dearth of concern with the complexity of factors involved in agricultural practices, both present-day and prehistoric. Often archeologists simply present a few summary statements of climatic factors, such as length of growing season and total annual precipitation, and then proceed with analysis and inferences as though this constituted sufficient control of all of the variables necessary to understand the prehistoric agricultural potential of a given area (e.g., Longacre 1968:91-92; McGregor 1965:28-29; Willey 1966:178-179). Chenhall (1972:figure 4) utilized data from the four weather recording stations closest to Vosberg Valley (Cibecue, Payson, Sierra Ancha, and Young) to plot mean monthly temperature against mean monthly precipitation for a 1-year period. The resulting curve showed a pattern of cold, moist winter months; warm, dry spring months; hot, moist summer months; and cool, relatively dry fall months. Such mean monthly data are useful in giving the reader a general picture of annual climate, but much greater detail is required if one is interested in the relationship between climate and agricultural practices in an area.

The entire State of Arizona has an arid to semi-arid climate due to its global latitude and placement in relation to major bodies of water. At least half of the State has an average annual precipitation of less than 25.4 centimeters (Green and Sellers 1964:8). The rugged mountain region in which Vosberg Valley is located is one of the most moist sections of the State; but, even so, total annual precipitation for the area is only 50.8 to 63.5 centimeters (Green and Sellers 1964:9). However, generalized data, such as yearly precipitation amounts, are not reliable indicators of the effectiveness of precipitation in plant or crop growth for, among other things, this depends upon the seasonal distribution of precipitation. Typically, Arizona experiences one period of precipitation in the winter and one in late summer. Additionally, Green and Sellers (1964:11) noted that

> Drought conditions are most common in Arizona in May and June. All parts of the state are affected by this late spring drought, with even the relatively moist central and Plateau sections going without rain in one month or the other in about one year out of every four.

Such a late spring drought occurred in 1974 as summer field work was interrupted when the Vosberg area, and other areas, were completely closed to the public by the Forest Service due to extremely dry conditions resulting from lack of rainfall in the previous few months. It is agriculturally significant that this dry season comes during the spring when an abundant supply of water is critical for seed germination and plant growth because, particularly in the elevated districts, the frost-free period remaining after summer rains begin is much too brief to allow crops to reach maturity.

There are a number of other factors which warrant exploration when considering relationships between moisture and plant growth. The character of precipitation in a given area can be important, for when precipitation falls as light showers, much moisture is lost to evaporation (Kramer 1949:55). On the other hand, when downpours occur, a common condition of summer rainfall in the Southwest, much moisture is lost as runoff; and such water loss through runoff is increased as degree of slope increases. Thus, the amount of precipitation produced in a given shower can rarely be directly translated into plant-available moisture; and it is necessary to shift attention to soil moisture conditions which result from that precipitation. Doneen and MacGillivray (1943) found, for example, that maize seeds give good germination results over a wide range of soil moisture conditions; but in controlled experiments when soil moisture fell below a condition called permanent wilting capacity, germination was severely affected. They also found that, though the length of time required for germination generally decreased with higher moisture conditions, extremely high moisture had a retarding effect upon seed germination. Shaw (1955), noting that moisture conditions prior to planting maize seeds are "especially important," explained this effect through his observation that under conditions of saturated soil seeds failed to germinate for lack of oxygen. In other experiments, Bair (1942) found that normal growth rates in maize plants are impaired, following germination, under conditions of low moisture supply. To this Wilsie (1962) has added the observation that a uniform amount of rainfall during the period of plant growth is much better than nonuniform conditions in which greater amounts are available during one part of the growth period than in another.

It must be kept in mind that climate consists of more than precipitation alone, and temperature variation also markedly affects plant growth. However, once again, generalizations such as growing

season length are not very informative indeces. Plant ecologists and botanists sometimes use the concept of growing season as generally indicative of the agricultural potential for a given area (Daubenmire 1965:191), but they usually caution that this climatic statistic must be used judiciously. Indeed, Landsberg (1935) has argued that the so-called "growing season," as determined by the long-term average of frost-free days, should not even be considered a significant climatological element. To support this position, he examined long-term climatological data for a specific area and found that, in over a fourth of the annual cases, the "growing season" deviated from the average by plus or minus three or more weeks. With such a range of variation, Landsberg felt that actual conditions are overly obscured upon being reduced to a single statistic such as growing season.

The nature of the relationship between temperature and plants becomes further complicated when one recognizes that the mere occurrence of freezing temperatures is not always sufficient to kill all kinds of plants, or even to kill the same kinds of plants at different periods in their growth processes. For instance, Wilsie (1962:381) noted that maize seedlings could withstand light frosts without injury while older maize plants were damaged by the same conditions. Lehenbauer (1914) found that specific temperature maxima and minima must occur for a given duration of time in order to effect a total kill. Thus the occurrence of frost conditions does not provide an obvious indicator of plant damage. When dealing with maize, one must also bear in mind the "tremendous genetic diversity and consequent range of adaptation" of this plant (Lehenbauer 1914:378). According to Shaw (1955), there are some varieties of maize which mature in 60 to 70 days and others which require as much as 10 to 11 months; and these different varieties display differential susceptibility to frost conditions. A single occurrence of frost will kill some varieties; for others, it takes several nights of frost; while still others can withstand several nights of freezing without damage (Shaw 1955:325).

Geomorphological factors can also modify the relationship between temperature and plant growth for, as Baker (1944:225) has pointed out, in mountainous terrain cold air flows downslope and gathers in flat-bottomed valleys, leaving the intervening ridges relatively warm. According to Wadleigh (1957:42), "Because freezing temperatures kill many kinds of plants, good management practices in orchards include provision for good air drainage down a

slope to minimize frost damage at flowering time in the spring." In an area where the time required for a given type of plant to mature sometimes exceeds the number of frost-free days, an advantage is afforded by the use of hill slopes for agricultural fields. In situations of this kind, a few extra days may also be gained for plant maturation by taking advantage of variability in the angle and exposure of hill sides. It is widely recognized that south-facing slopes in the northern hemisphere receive the sun's rays more directly, and are thus warmer, than north-facing slopes in the same valley (Billings 1970:15). Shreve (1927) has noted that slopes of differing exposure within the same valley may have growing seasons of different lengths. Seeds planted in the warmer soils of the south-facing slopes normally sprout more rapidly and get a head-start on those planted on north-facing slopes.

The preceding considerations represent only some of the most widely studied aspects of the relationship between plants and climate, but these are the kinds of factors which archeologists concerned with prehistoric agricultural practices must attempt to assess in different, specific situations because any or all of them may have been significant to such practices. An excellent illustrative example of the importance of some of these factors is provided for us in an ethnographic study of Hack (1942) which focused attention on the relationship between Hopi Indian agriculture and conditions of the surrounding physical environment. The Hopi reservation is located in northeast Arizona in an area of very low rainfall and a relatively short season of frost-free days. Such conditions have evoked a number of behavioral responses on the part of Hopi agriculturalists who employ very few, if any, sophisticated techniques in their farming practices. According to Hack (1942), areas around the reservation with only 110 to 120 frost-free days are areas of no corn production; the Hopi plant corn in areas of at least 130 frost-free days. Because the Hopi environment is also very dry, the limiting effects imposed by a relatively brief frost-free season become even more critical. Under conditions of poor moisture supply, the normal growth rate of maize and other plants is retarded. To insure against total loss of crops from frost damage, the Hopi plant their maize on a staggered schedule with some being planted as early as April 15, but with the major planting taking place as late as the middle of May. The main harvest then occurs about 130 days later around September 25. The danger of frost damage is also minimized by planting seeds at a depth of 10 to 15 inches, but the main reason for such deep planting

is to take advantage of ground water supplies. Hopi country rarely receives rainfall in the months of May and June, the months in which an adequate water supply is necessary if maize and other crops are to grow properly. The Hopi have responded to this seasonal drought by choosing a variety of topographic and hydrologic situations for location of agricultural fields. Basically they practice four different methods of farming: (1) flood-water farming from surface runoff; (2) farming in fields watered by underground seepage; (3) sand dune farming using rainfall; and (4) irrigation farming. Indeed, water is such a critical element that Hack (1942:10) was led to suggest that, "In a region as dry as the Hopi country, water supply is probably the most important environmental factor determining the concentration of population."

Turning now to the specific case of Vosberg Valley, we find an area of slightly different conditions than those in Hopi country, but an area where conditions for prehistoric agriculture still would have been marginal at best. Continuously recorded climatological data from the weather reporting station at Young, Arizona, a few kilometers to the northwest of Vosberg Valley, are available only for the recent past (Climatological Data, Arizona); but such data from the years 1962 to 1970 reveal that the frost-free season here is relatively brief (table 13). The average frost-free season for the 9-year period is 120 days; but, even in this small number of cases, there is marked deviation from the average. The lower extreme is 88 days, and the upper extreme is 151 days, a difference of 63 days.

Table 13

FROST-FREE SEASON AT YOUNG, ARIZONA, FROM 1962 TO 1970

Year	Last Spring Freeze	First Fall Freeze	Frost-free Days
1962	June 16	October 8	114
1963	June 14	October 14	127
1964	May 29	October 22	146
1965	June 25	September 21	88
1966	June 3	October 14	133
1967	June 11	October 8	118
1968	June 10	September 18	101
1969	May 7	October 5	151
1970	June 15	September 24	101

Prehistorically, temperature conditions may have been different. On the basis of "hints" by Schoenwetter (1962) and "suggestions" by Hevly (1964), Longacre (1968:93) concluded that there was a drop in mean annual temperature of about 2^{o}-3^{o} F. around A.D. 1300 in east-central Arizona. This seems almost purely speculative on Longacre's part; but, granting the possibility that this is accurate and that past mean annual temperatures in the Vosberg area were higher, conditions probably still would have been agriculturally marginal. Suppose that past temperatures were high enough to have afforded a season of 130 frost-free days. We have seen in the Hopi example that, even though crops were planted in areas having 130 or more frost-free days, it was still necessary to take special precautions to protect crops from frost damage (Hack 1942). Hill (1970a:6) noted that present-day people in the Snowflake, Arizona, area, where the frost-free season averages 133 days, refrain from dry farming because of low summer nighttime temperatures and that "A few people do grow crops with irrigation, but the region is most efficiently utilized as range for cattle."

As we noted previously, total annual precipitation in the Vosberg area ranges from 50.8 to 63.5 cm.; but, distributionally, there is a period of drought in the spring months similar to that in Hopi country to the north. Figure 12, taken from climatological data at Young, Arizona (Climatological Data, Arizona) graphically depicts the seasonal distribution for a selected 3-year period.

The relationship between present-day and prehistoric moisture amounts and distribution in the Southwest is not clear, for, despite a number of studies which have addressed the question, there is still considerable room for debate on the results. Maps prepared by Robinson and Dean (1969) on the basis of tree-ring studies show that, for most of the A.D. 1000 to 1200 period, amounts of moisture available for tree-ring growth in the Vosberg area were not "significantly" different from those of today. However, archeological palynologists argue that, rather than amount alone, the distribution of precipitation was an important factor in prehistoric agricultural practices; and they suggest that prehistorically there may have been a shift in the seasonality of precipitation in the Southwest (Martin 1963; Schoenwetter 1962). Hill (1972:82-84) reviewed the evidence compiled in a number of palynological studies from the Southwest (Hevly 1964; Leopold, Leopold, and Wendorf 1963; Martin 1963; Schoenwetter 1962; Schoenwetter and Eddy 1964) which document a change in the pollen record of the past from a condition of relatively abundant arboreal pollen to one of relatively abundant non-arboreal pollen.

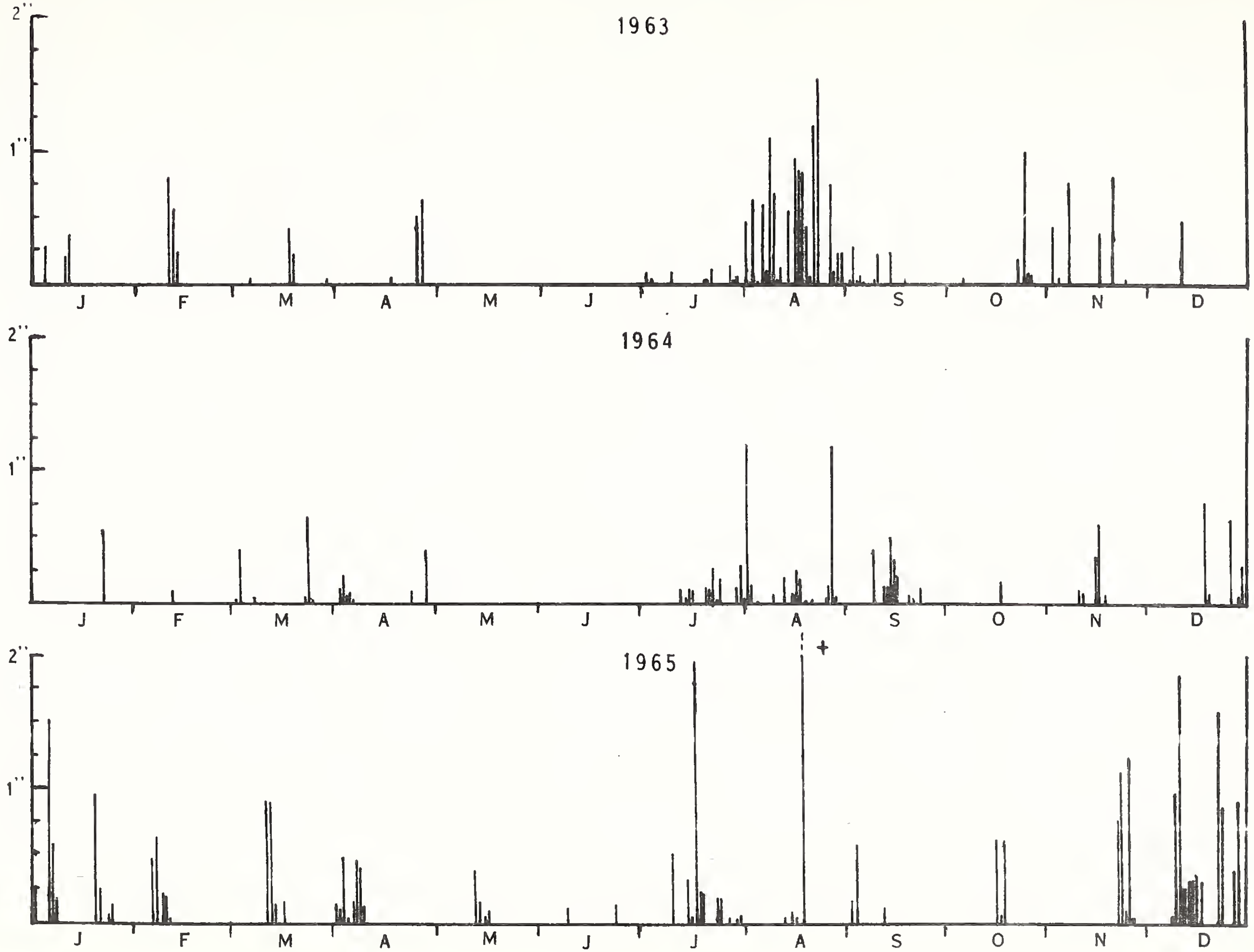


Figure 12. Annual distribution of daily precipitation at Young, Arizona, for three-year period.

A major problem with this change is that analyses indicate wide divergence in the time of its occurrence, ranging from as early as A.D. 800 in the Navajo Reservoir District (Schoenwetter and Eddy 1964) to as late as A.D. 1400 in the Tesuque, New Mexico, area (Leopold, Leopold, and Wendorf 1963). Hill (1970a:83) chose to ignore the early Navajo Reservoir District date and, by some means not entirely clear, derived average inclusive dates of A.D. 1100 to 1300 for the shift, also ignoring the possibility that there could have been a number of shifts occurring at different times in different places. Hill proceeded to argue that such a shift in the pollen record reflects a change in the composition of vegetation brought on by an environmental shift. Though citing three possible forms which such an environmental shift could have taken, he chose to accept that it was due to a shift in the periodicity of precipitation because, "All of the palynologists cited seem to agree with this idea" (Hill 1970a:84).

The point on which palynologists agree is that there have been shift(s) in the periodicity of precipitation in the past, but not all agree that such shifts are evidenced in changing pollen spectra. Schoenwetter (personal communication; Schoenwetter and Dittert 1968:44) takes the position that only geological cut-fill data, and not pollen data, offer adequate evidence for prehistoric changes in precipitation periodicity. Hill did not mention an argument by Schoenwetter and Dittert (1968), based upon the analysis of Schoenwetter (1966:23), that such a periodicity shift may have occurred in the Northern New Mexico area around A.D. 750 to 775 but may not have been widely evidenced geologically at the time.

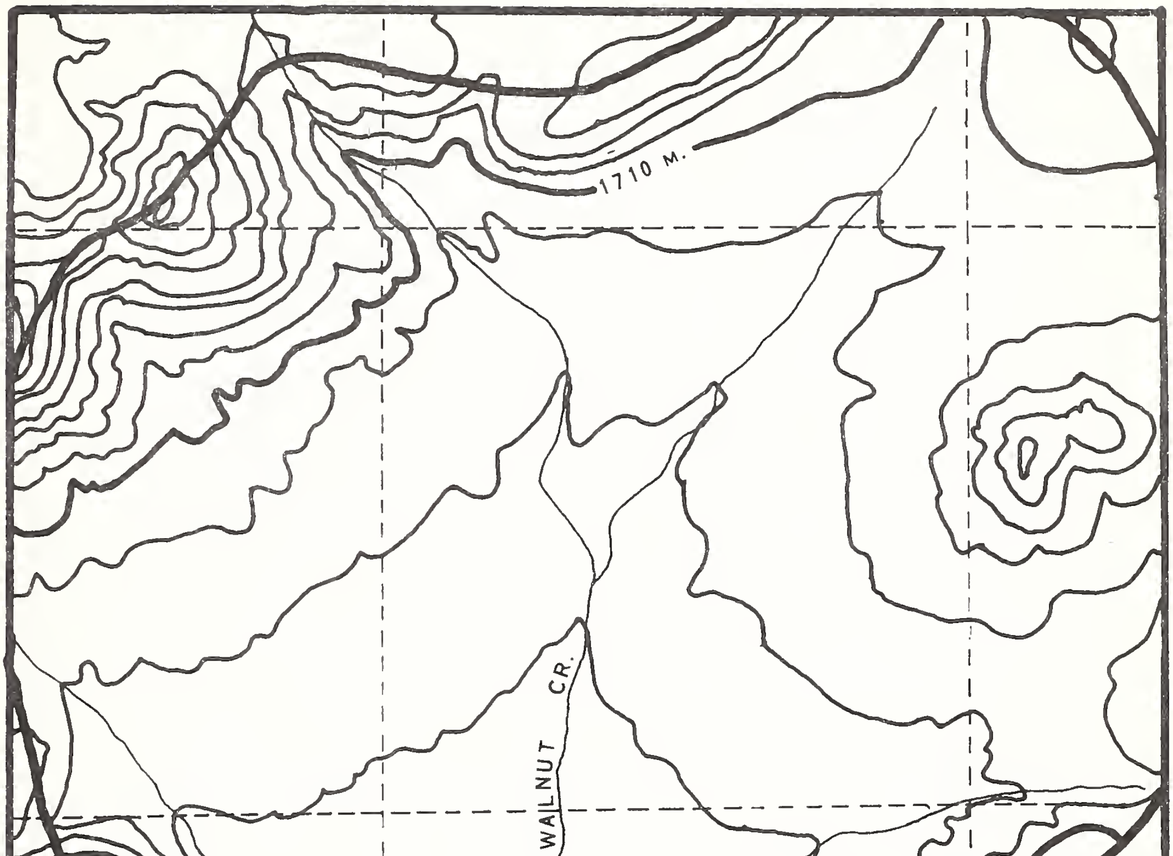
The pollen record of the A.D. 1050 to 1250 period for Vosberg Valley shows uniformity from the beginning to the end of the period and, hence, does not show the sort of shift which occurred in those areas cited by Hill. However, the valley's pollen record of this prehistoric period is statistically dissimilar to that from the modern surface. According to Schoenwetter (personal communication), this indicates that a change of some kind has occurred in the physical environment of the Vosberg area in the past 800 years, but the interpretation of this change remains open to speculation. At present, geological data from the Transition zone which might shed light on the problem are completely lacking.

In the final analysis, it must be acknowledged that, essentially, paleoenvironmental conditions in the Vosberg area are yet to be determined, and this problem must await future studies. This

being the case, it is necessary to reconstruct past conditions based upon extrapolations from those of the present. There is no question that present-day conditions for agriculture in Vosberg Valley are marginal; and, unless there has been a very dramatic change in the past 1000 years, which is not even suggested in any Southwestern paleoclimatic studies, it is safe to assume, lacking contradictory evidence, that conditions were also marginal for agriculture in the A.D. 1050 to 1250 period. Of course, most of the smaller scale relationships between climate and plants discussed above, such as slope-facing effects or variable moisture effects, would apply uniformly regardless of slight differences in climate.

Local Topography, Hydrography and Agricultural Potential

Topography and consequent drainage patterns are also important considerations in assessing agricultural potential of an area. Vosberg Valley is an enclosed drainage basin, drained by Walnut Creek and its many small tributary washes and arroyos. Moving away from Walnut Creek toward the valley margins on all sides, slope becomes increasingly pronounced to a point where the limits of the valley are well defined by an encircling series of hills, saddles, and steep scarps of varying heights. The long axis of the valley runs from a few degrees east of north to a few degrees west of south and generally parallels the main channel of Walnut Creek (figure 13). The valley is relatively small; its entire length is only slightly over 4 kilometers, and its maximum width is on the order of 3.2 kilometers. The valley floor, generally lying at an elevation of 1610 meters, is the most nearly level portion of the valley; but, even here, the relief is over 38 meters per kilometer. The western boundary of the valley is formed by Vosberg Mountain on which the highest prominence is 1875 meters in elevation, some 265 meters above the valley floor. The east-facing side of this mountain which overlooks the valley is, for the most part, a sheer cliff on which the most dramatic dropoffs reach heights of 120 to 150 meters. Catholic Peak in the northwest corner of the valley reaches an elevation of 1967 meters. The valley floor gradually slopes up as one moves north to a point where a relatively low scarp rises abruptly to a height of about 46 meters, demarcating the northern boundary of the valley. A relatively isolated hill at the northeastern corner of the valley flanked by open areas composed of low saddles rises to 1785 meters. Finally, a semi-circle of hills and saddles rising from 45 to 90 meters above the valley floor defines the eastern and southern boundaries, and a small opening in the southwest corner gives exit to Walnut Creek.



From Chenhall 1973: Map 1
Figure 13. General topography of Vosberg Valley.

In an east-west direction, Vosberg Valley offers a good example of valley asymmetry which, according to geomorphologists (e.g., Leopold, Wolman, and Miller 1964), is a condition occurring where one slope of a valley is relatively steep while that of the other side is more gentle. Some general causes of valley asymmetry are known, but it is also recognized that its causes vary with climatic and geomorphological variability. Melton (1960:142) has argued that, ". . . most cases of valley asymmetry can probable be attributed directly to asymmetric basal corrosion," i.e., to differential erosive processes due to greater proximity of a stream channel to the base of one slope or the other. In Vosberg Valley, the slope on the east side of the valley is relatively gentle until one reaches the very margins where it becomes more pronounced, while the west side is formed by the steep eastern face of Vosberg Mountain. Immediately at the base of Vosberg Mountain is one of the larger tributaries of Walnut Creek. Material eroded from the cliff face is quickly transported downstream, out of the valley, and a gentle slope has been unable to form. The general consequence of this asymmetry for agriculture is that there is much greater soil development and density of vegetation on the east side of Vosberg Valley than on the west side. The valley is also asymmetrical in a north-south direction, but this is much less pronounced.

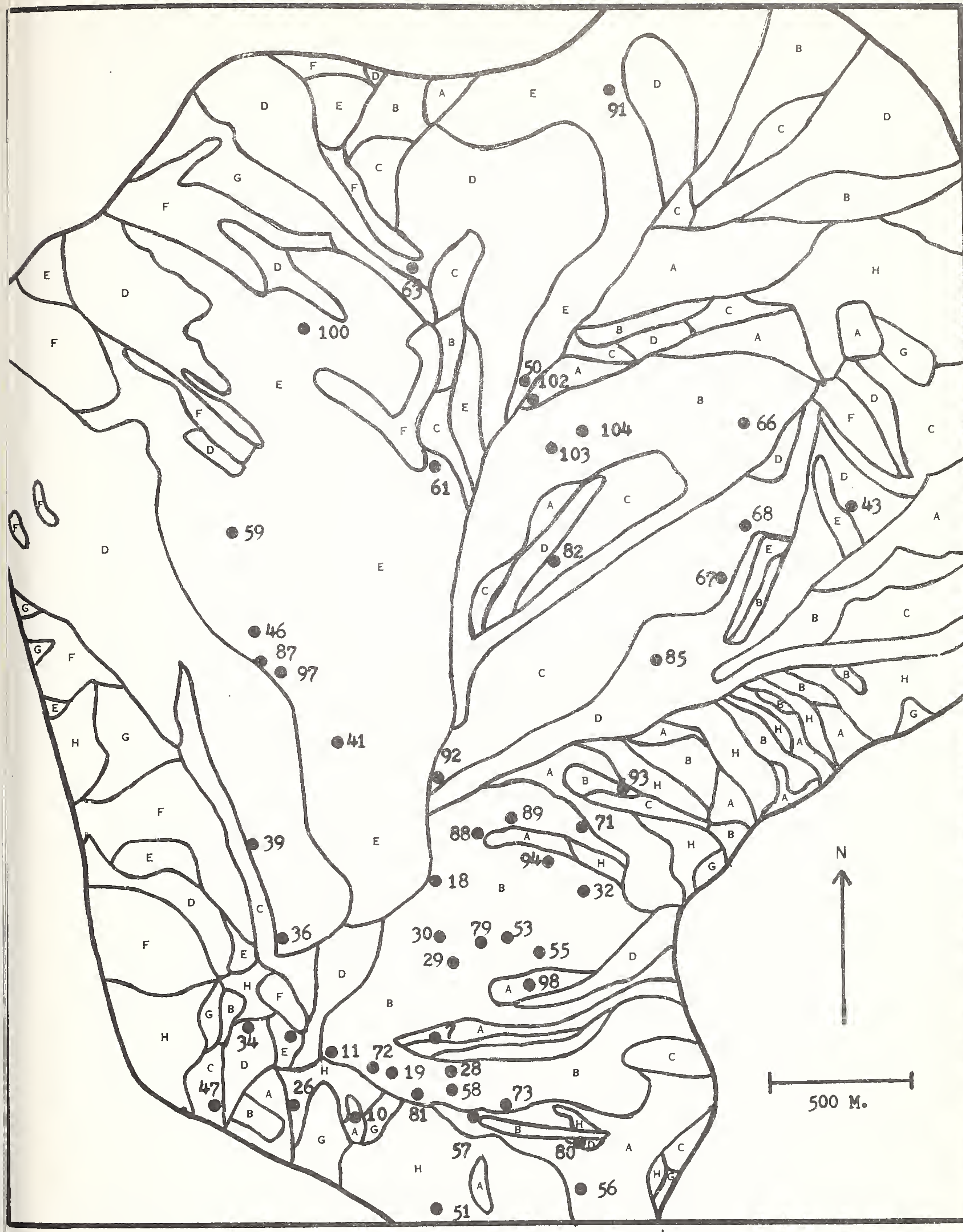
Of course topography can be examined in greater detail than is seen in the foregoing consideration; and, in fact, closer scrutiny is preferable if one's interest lies with a study of agriculturally significant variation (see Test Implication B of Secondary Hypothesis III). In a more finely focused examination, slope-facing takes on an important role because crops planted on south-facing slopes enjoy a few more days of warmth than crops planted on north-facing slopes. Additionally, Shreve (1927) has pointed out that west-facing slopes are slightly warmer than east-facing slopes. This differential warming is due to the fact that slopes with south and west exposures receive the sun's rays more directly than do those facing in other directions. The few extra days of growth afforded crops planted on warmer slopes could make the difference between a relatively good harvest and a poor one. However, we must also consider that those slopes which receive the greatest warmth due to more direct sunlight are the more xeric slopes for the same reason. A few extra days of potential growth per season may mean nothing if the soil becomes too dry for proper plant growth; thus, it can be argued that, in a situation of low rainfall such as Vosberg Valley, those slopes having greater moisture preservation capabilities will be agriculturally preferable.

Figure 14 is a map taken from Chenhall (1972:map 4) on which he has divided slope-facings in the valley into eight subclasses: (1) east-facing, (2) northeast-facing, (3) north-facing, (4) northwest-facing, (5) west-facing, (6) southwest-facing, (7) south-facing, and (8) south-east-facing. Using the criterion established above, it is possible to rank those subclasses in a general way with respect to agricultural potential. The more mesic slopes, subclasses 1-4, are ranked higher than the more xeric slopes, subclasses 5-8.

We may now turn to a consideration of the role of slope angle in agricultural practices. With present-day farming practices as a standard, we tend to think that level land is the most desirable kind for intensive cropping; and the vast expanses of level land in the Plains and middle western United States which are now farmed intensively bear out this expectation. These two regions also have optimum conditions of soil types, temperature, and precipitation. Ethnographic examples, however, would indicate that Indian agriculturalists tended to accept conditions in the area where they happened to be living and make use of natural situations and feasible technological devices which would improve their chances of getting adequate crop returns. Under conditions of low precipitation and/or an abbreviated frost-free season, fields were located in places where maximal advantage could be taken of whatever moisture was available and where maximal protection from frost damage was possible. The Hopi example is a case in point.

It has already been pointed out that planting on sloping land surfaces minimizes the chances of frost damage because cold air drains downslope to valley bottom areas. But the use of a sloping surface for agricultural fields may also enhance plant-available moisture conditions if conditions of soil stratigraphy and/or texture are also favorable. In Vosberg Valley, it is relevant to consider the nature of local soils because, generally speaking, soils on the flatter valley floor are coarse-textured and have low to moderate moisture storage capacities. But, as one moves out from the valley floor to steeper areas, soils with finer texture and high moisture storage capacities are encountered. In terms of their relative capacities to retain moisture, soils on the slopes are agriculturally more desirable than those on the valley floor.

However, there is yet another, and probably more important, reason why sloping surfaces might have been agriculturally more important than level surfaces, particularly given conditions of low rainfall.



Adapted from Chenhall 1972: Map 4

Figure 14. Slope-facing variability and site location in Vosberg Valley (Key on following page)

Key to Figure 14

A - Northwest-facing
B - West-facing
C - Southwest-facing
D - South-facing
E - Southeast-facing
F - East-facing
G - Northeast-facing
H - North-facing

In both soil sampling and site excavation in Vosberg Valley, it was noted that an impervious layer, usually diabase or weathering diabase, underlies a loose top soil layer at a depth of 15 to 45 cm. According to Buckman and Brady (1969:188), an impervious subsurface layer of this sort acts as a barrier to free gravitational drainage of moisture; and, in such a situation, the upper part of the soil takes on and holds more moisture than might be expected. When this occurs on a sloping surface, the trapped water in the upper soil layer begins to flow slowly downslope under gravitational forces. This laterally directed water is referred to as "throughflow" (Carson and Kirkby 1972:47). Figure 15 is a schematic representation of throughflow. The potential importance of throughflow is that, following rainfall, the flow ". . . is continued for a matter of weeks at measurable levels, and is of the right order of magnitude to account for base flows in upland basins on impermeable bedrock" (Carson and Kirkby 1972:55). It is evident that agricultural crops planted at the lower reaches of, or even part way up, sloping land surfaces in Vosberg Valley would enjoy prolonged or perhaps even sustained moisture conditions at the root level despite relatively low amounts of precipitation.

Given the advantages afforded by planting crops on sloping land surfaces, this environmental dimension can be ranked by subclass with respect to agricultural potential. Chenhall (1972:map 3), in working with a different problem, defined four subclasses of slope angle in Vosberg Valley: (1) 0-5 percent, (2) 5-10 percent, (3) 10-15 percent, and (4) 15+ percent. His classification excluded portions of the valley with extremely steep slopes, and the present study which uses the categories set up by Chenhall also excludes such extreme slopes by virtue of their uncultivable nature. In the case of Vosberg Valley, slopes of 15+ percent are ranked best for agriculture, and those of 0-5 percent are ranked poorest. The distribution of lands with different slope angles is shown in figure 16.

At this point, it is desirable to combine the dimensions of slope direction, discussed previously, with that of slope angle. This procedure reduces the number of dimensions which will eventually need to be considered in setting up land-capability classes. Furthermore, it does no harm to the data since slope angle and facing are closely interrelated. Zones of different slope-facing and slope angle are scattered around the valley, some in relatively large contiguous land areas but mostly in small disconnected plots. In order to combine these dimensions into a single dimension, slope

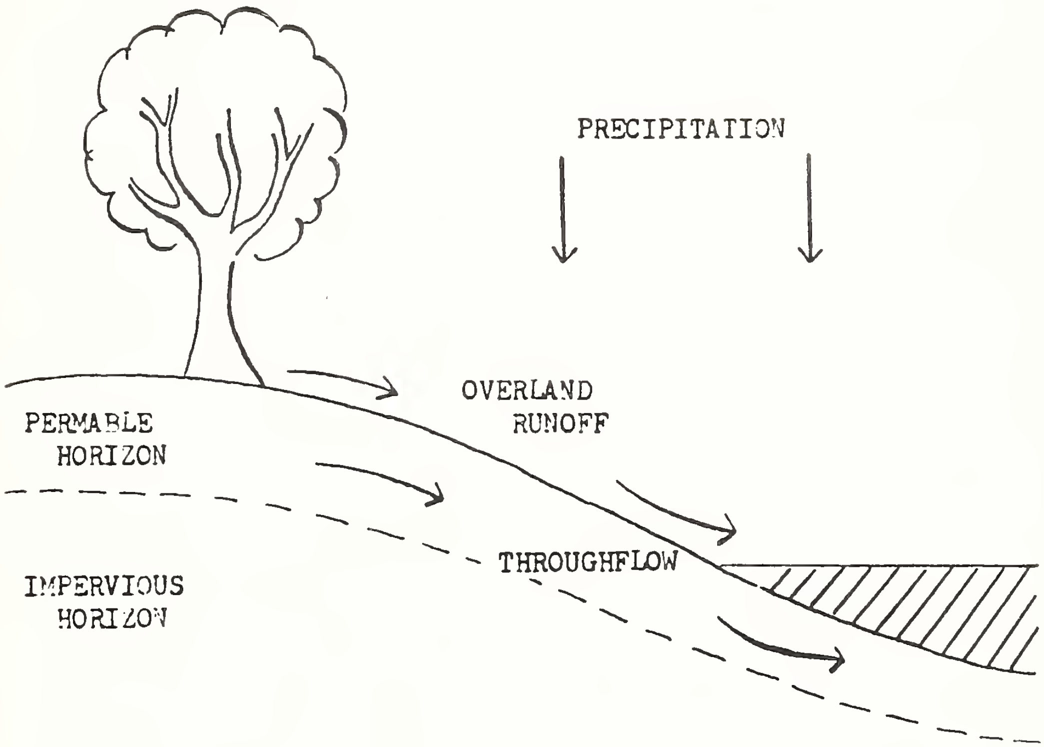
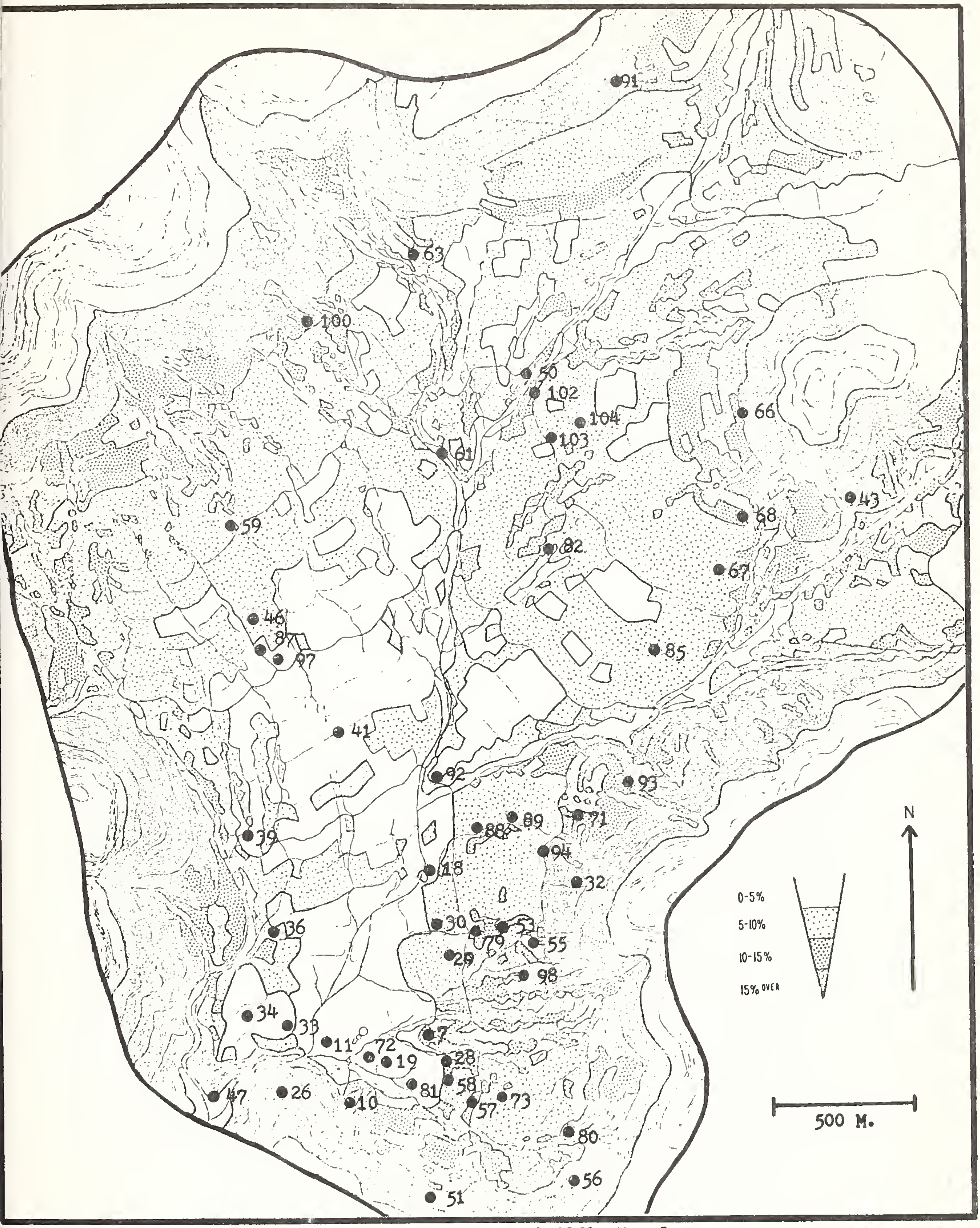


Figure 15. Throughflow on a sloping surface
(After Carson and Kirkby 1972:47)



Adapted from Chenhall 1972; Map 3
Figure 16. Slope angle variability and site location in Vosberg Valley.

angle was first arranged in its hierarchical order. Then each slope angle dimension was subdivided to allow for different slope-facing dimensions. The highest ranked subdivision within each slope angle class contains the four highest ranked slope-facing subclasses, and the lowest ranked contains the four least desirable slope-facing subclasses. This procedure yields combined rank categories, used below in conjunction with other ranked dimensions to establish land-capability classes, which form a series of eight ranked zones as listed in table 14.

The hydrographic situation in Vosberg Valley is closely related to topography and climate. Additionally relevant to hydrography is the fact that naturally occurring springs are common throughout the mountainous zone below the Mogollon Rim (Feth 1962) and, after precipitation, they constitute an important source of water for the valley. During the survey conducted in the summer of 1974, only a few of the valley's springs were active. The major one at the present time, and no doubt in the past, is located near the old Flying V ranch house at the southern end of the valley. This spring feeds directly into the main channel of Walnut Creek which becomes a permanently flowing creek below this point. Further upstream are two or three seep areas, but their flow is so minimal that the water produced soaks back into the sandy arroyo bottom before traveling very far downstream. Thus, the main channel of Walnut Creek is essentially a dry arroyo for well over 90 percent of its length within the valley. Additionally, all of the major and minor arroyos and washes feeding into Walnut Creek are presently dry. These conditions may or may not have been present in the past, for, if the water table was previously higher, there may have been greater spring activity and a perennial water source, at least in the main channel of Walnut Creek.

During some of the heavier cloudbursts which are typical of the area in late summer, the arroyo system in the valley comes briefly to life. In the summer of 1974, one thunderstorm poured well over an inch of rain in about 30 minutes. Within a few minutes after the rain had ceased, only the main channel of Walnut Creek continued to flow and, at most, this flow lasted only a few hours. But not all precipitation falls so violently, and that which results from brief, light, or slowly falling showers is simply not sufficient to initiate stream flow. Summer precipitation is often of the former type and winter precipitation of the latter. Because snow melt

Table 14

COMBINED DIMENSIONS OF SLOPE ANGLE AND SLOPE-FACING
RANKED BY AGRICULTURAL POTENTIAL

Rank	1	2	3	4	5	6	7	8
Facing	E-NE-N-NW	W-SW-S-SE	E-NE-N-NW	W-SW-S-SE	E-NE-N-NW	W-SW-S-SE	E-NE-N-NW	W-SW-S-SE
Slope %	15+%		15-10%		10-5%		5-0%	

generally occurs too gradually to initiate runoff, most of the winter precipitation remains in the valley to replenish ground water supplies while a great deal of the summer rainfall is lost downstream.

To a large degree, topography dictates the configuration of the valley's network of washes, arroyos, and creeks (figure 17). The large arroyo on the west side of the valley at the base of Vosberg Mountain readily transports runoff in that area out of the valley. Topographic-hydrographic runoff conditions in the rest of the valley can be described in geomorphological terms. Troeh (1965) worked out mathematical means for characterizing different slopes, and Bloom (1969), borrowing from Troeh, recognized two general kinds of slopes: water-spreading and water-gathering. Slopes of the former class have convexly bulging contours which spread water laterally as it moves downslope, while water-gathering slopes have concave contours which gather and concentrate water as it moves downslope (figure 18).

The bowl-like area formed by the hills and saddles on the eastern and southern sides of Vosberg Valley fits readily into the class of water-gathering slopes, but the majority of the valley floor outside of the southeastern corner can be characterized as water-spreading slopes. One consequence of these slope differences can be seen in the arroyo network in different parts of the valley (figure 17). The southeastern part of the valley is virtually honeycombed with numerous, small arroyos and washes which have carved the landscape into a bewildering series of small knolls, ridges, and saddles superimposed on several larger colluvial ridges which extend from the valley's margins toward its center; in any other part of the valley water courses are less concentrated. Such differences may be expressed mathematically as "drainage density" (see Leopold, Wolman, and Miller 1964), which is the quotient of cumulated stream length divided by a given area, i.e., drainage length per unit area. The formula is:

$$\text{Drainage density} = \frac{\Sigma L}{A}$$

The drainage network for Vosberg Valley shown in figure 17 was determined by visual inspection of aerial photos and includes those arroyos and washes large enough to be readily seen in the photo. The valley was then divided into six zonal subunits of approximately equal area, numbered in figure 17 with Roman numerals, and drainage

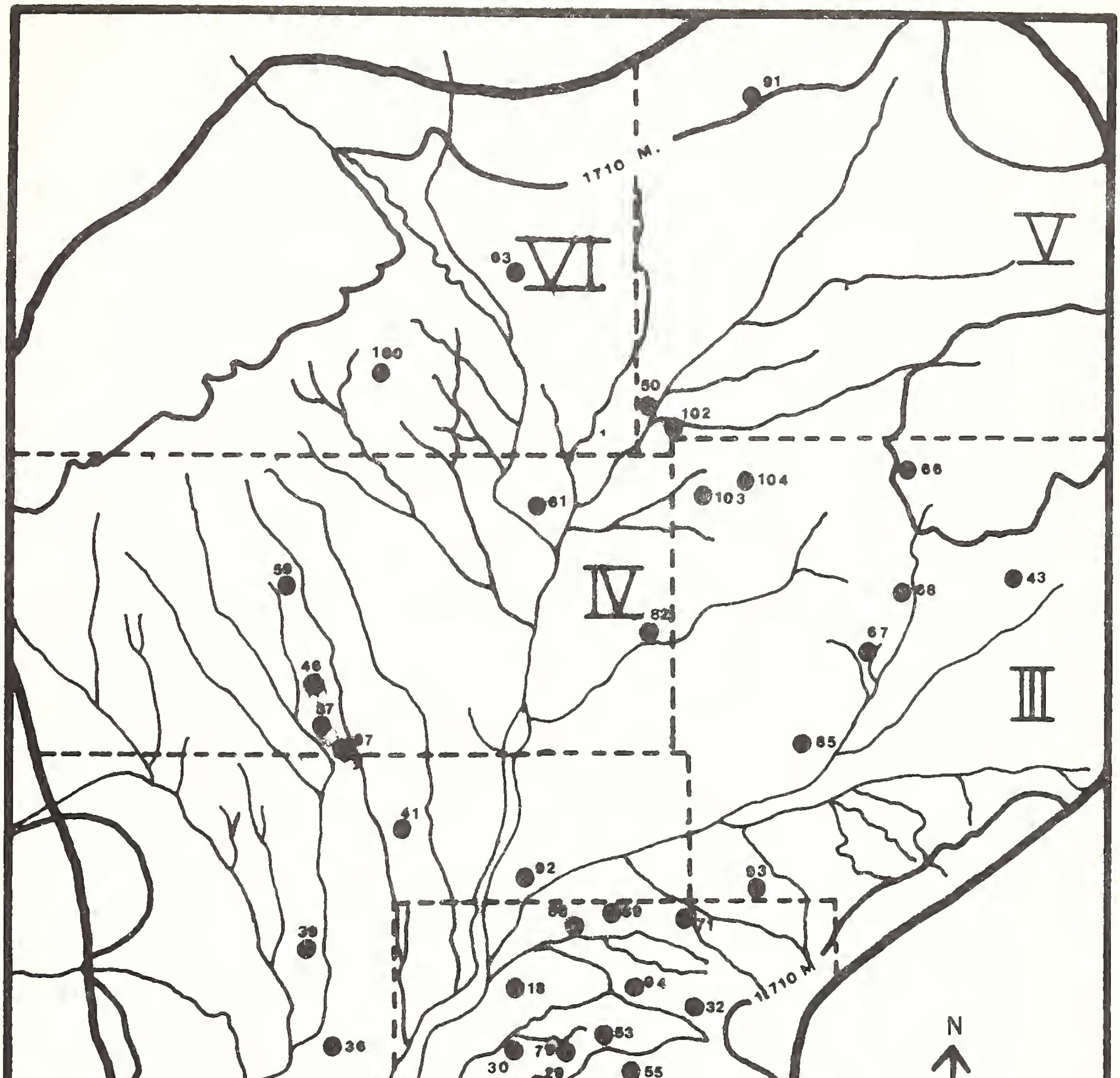


Figure 17. Hydrographic variability and site location in Vosberg Valley.

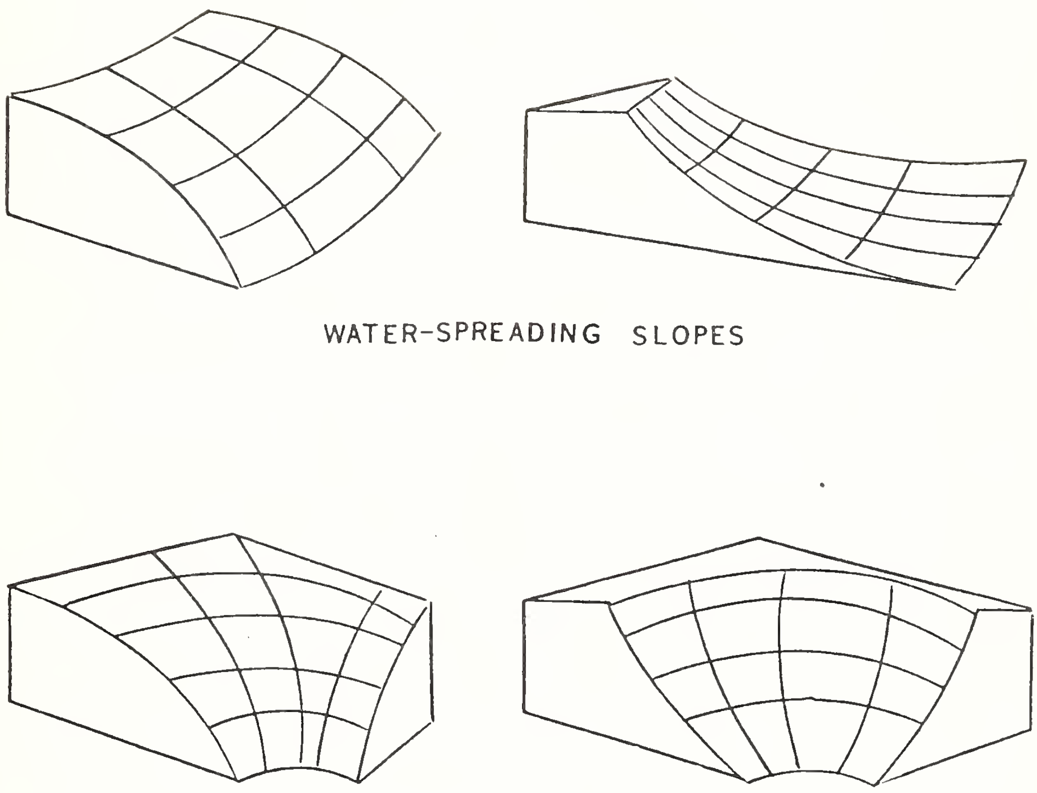


Figure 18. General hydrographic slope types
(After Bloom 1969:51)

density was calculated for each. Of course, an index like drainage density is a general statistic based on area and cannot be used in a direct fashion to account for specific requirements of site location. But this statistic does afford a means of quantifying and comparing, for different sections of the valley, the relative densities of potentially divertable water courses and, hence, affords a means of comparing areal variability in the potential for flood water irrigation. Using drainage density, the six hydrographic zones can be ranked with respect to agricultural potential as presented in table 15.

Table 15

HYDROGRAPHIC ZONES RANKED BY AGRICULTURAL POTENTIAL

Zone	Area km^2	Drainage Length-m	Drainage Density-m/km^2	Rank
I	1.69	14,300	8,461	1
II	1.69	7,575	4,482	3
III	1.69	6,325	3,743	4
IV	1.69	9,300	5,503	2
V	1.69	4,050	2,396	6
VI	1.69	4,900	2,899	5

Local Soils and Agricultural Potential

The most important factor to be considered in assessing agricultural potential is soil because of the wide variety of significant interrelations between plants and this medium in which they must grow and survive. According to Oosting (1956:75), "Soil must provide plants with anchorage, a supply of water, mineral nutrients, and aeration of their roots." Of course, these factors are interrelated to a degree, but Oosting (1956:178) further noted that

> Soil water probably affects plant growth more commonly than any other soil factor. It follows, therefore, that a basic understanding of what causes differences in amount and availability of soil moisture and what such differences may mean to a plant is knowledge necessary for an ecologist.

The principal determinant of water retention capability in soil is particle size or texture, for, as Kramer (1949:26) noted, water retention in soil takes place through surface forces which bind water to soil particles. The two extremes of particle size afford the poorest water retention capability. Sandy soils, being composed of relatively large particles, offer the least amount of particle surface area for moisture attraction and retention, and moisture is quickly lost from a sandy soil, both gravitationally and through evaporation. Although a fine clay soil has the greatest amount of particle surface area and will, in fact, hold the greatest amount of moisture, much of this moisture is so tightly bound to the tiny particles that it cannot be utilized by plants (Oosting 1956:188). A pure clay is thus not a desirable agricultural soil. The best all-around agricultural soil is loam with more or less equal amounts of sand and clay, or clay and silt. Such soil has excellent moisture retention properties and also provides desirable conditions for related properties of nutrient and organic content and aeration (Kramer 1949:20).

The question of agriculturally significant soil variability in Vosberg Valley necessitates an initial brief examination of the geology of the area. No detailed geologic study has been done for the valley itself, but one such study is available from the nearby Fort Apache Indian Reservation which Moore (1968) divided into geologic subprovinces. His Canyon Creek-Salt River Canyon subprovince, which lies only a few kilometers east of Vosberg Valley, includes formations ranging in age from the Precambrian through the Quaternary. At various localities within the subprovince, there are pockets of Precambrian diabase, intruded as dikes and sills (Moore 1968:25). Such diabase formations occur in the Vosberg area also as noted by Shride (personal communication in Chenhall 1972:14-16) who conducted a mineral survey in the Vosberg area and recalled that Vosberg Valley is "nearly everywhere floored by diabase."

However, it would be an oversimplification to characterize Vosberg Valley's soil as completely diabase-derived. A soil map is available for that part of the Tonto National Forest in which Vosberg Valley is located (Broderick 1971). According to Broderick's map, reproduced in figure 19, diabase does indeed underlie the entire valley floor and even extends partially up some of the slopes. However, for the most part, soils on the slopes around the valley margins

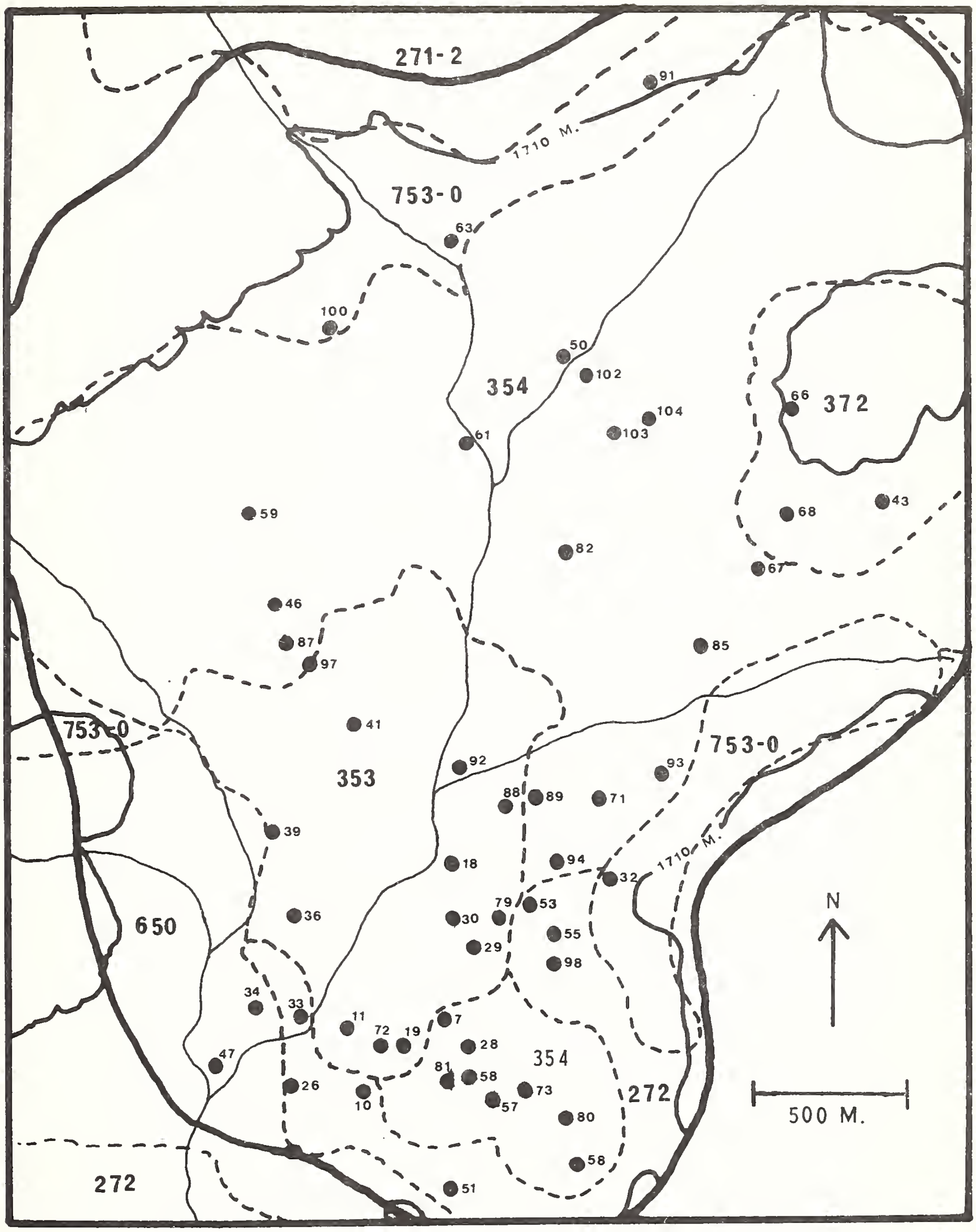


Figure 19. Edaphic variability and site location in Vasberg Valley (Key on following page).

Key to Figure 19

Mapping Unit	Selected Characteristics*
271-2	Deep, low fertility, fine-texture, platy clay soils from sandstone, siltstone, and quartzite. High moisture storage.
272	Moderately deep, highly productive, fine-textured, silty clay loam soil from sandstone. High moisture storage.
353	Shallow to moderately deep, moderately productive, coarse-textured, sandy loam soil from diabase. Moderate moisture storage.
354	Shallow, moderately productive, stony, coarse-textured, sandy loam from diabase. Low moisture storage.
372	Deep, highly productive, stony, fine-textured, sandy clay loam from diabase. High moisture storage.
650	Mostly sandstone and quartzite bedrock outcrops with inclusions of moderately fine- to coarse-textured colluvial soils. Low moisture storage.
753-0	Deep, moderate to poorly productive, fine-textured, calcareous, colluvial soils from shale, siltstone, and sandstone. High to low moisture storage.

*Condensed from Broderick (1971).

are not diabase-derived but are formed from more erosion-resistant rock types which cap the tops of valley margin hills. The parent materials for these soils include shale, siltstone, sandstone, and quartzite.

The soil map provided by Broderick shows that valley margin soils are deeper, finer-textured, higher in moisture storage capabilities, and generally more productive than the diabase-derived soils of the valley floor. Analysis of soil samples collected during 1974 field work supports Broderick's findings in that diabase-derived valley floor soils contained up to 95 percent sand-sized particles. Soils with such high sand content have poor moisture storage capabilities. We need not conclude that the valley margin soils are ideal, for surely they are not; but, relative to soils on the valley floor, they have a number of agriculturally preferable qualities. Thus, Test Implication D of Secondary Hypothesis III, which predicts agriculturally significant edaphic variability, is supported.

Using descriptive data provided by Broderick (see key to figure 19), it is possible to rank different soil zones in Vosberg Valley in terms of agricultural potential (table 16).

Table 16

SOIL ZONES RANKED BY AGRICULTURAL POTENTIAL

Rank	1	2	3	4	5	6	7
Soil Type	372	272	753-0	353	354	650	271-2

Prehistoric Land-Capability Classes

Secondary Hypothesis III predicted both the presence of a variety of land areas having a range of agricultural capabilities in Vosberg Valley and of limited quantities of good land. The preceding analyses of several environmental dimensions are sufficient to establish the validity of the first part of this hypothesis, but the data necessary to test the latter part cannot be obtained in a straight forward manner because that land which is, in fact, the "best" for agriculture is not an apparent nor readily definable entity. One can imagine an experimental approach to the problem in which crops would actually be planted at a number of locations around the valley, selected to

reflect different sets of ecological circumstances. The resultant harvest could then be used as an objective index of the relative agricultural merit of different plots of land. However, such an approach is fraught with obvious logistic difficulties. But even if these could be overcome, temperature and precipitation fluctuate rather markedly from year to year, and one would really need to continue experimentation over a period of some generations to obtain results which could be applied as convincing controls for the archeological record. Besides, an experimental approach does not avoid the necessity of determining which environmental criteria should be used to define ecologically different situations in which to plant crops.

The present study approaches the problem from a more inferential perspective. It presumes that variability in agricultural potential can be determined using a framework wherein analytically derived weights are assigned to various physical attributes of different plots of land. The physical attributes selected as relevant to the problem have been chosen on the basis of archeological observation specific to Vosberg Valley in conjunction with concepts and conclusions drawn from the literature of scientific fields such as plant ecology and soils studies. Field observation (Rodgers 1970) disclosed the types and locations of a number of soil and water control devices used by prehistoric agriculturalists in Vosberg Valley. With this information, actual prehistoric agricultural practices can be given consideration in establishing and assessing relevant environmental variables. Variables chosen for these purposes were soils, hydrography, slope angle, and slope-facing which, in the preceding sections of this chapter have been analyzed separately in order to determine how each dimension could best be divided into subclasses reflecting differing agricultural potential. The resultant subclasses for each dimension were then assigned rank order categories, designed to give the highest rank to that subclass with the highest agricultural potential.

The United States Soil Conservation Service has established a system of land-capability classification (Buckman and Brady 1969:351-352) which combines and gives simultaneous consideration to a number of variables having different variable states. This system can be used as a framework for analysis of the three environmental dimensions deemed important to prehistoric agriculture in Vosberg Valley. The Soil Conservation Service system recognizes eight different land-capability classes:

> These classes are numbered from I to VIII. Soils having greatest capabilities for response to management and least limitations in the ways they can be used are in class I. Those with little capabilities and great limitations are found in class VIII. (Buckman and Brady 1969: 351-352).

For the present study, only the principle of the Soil Conservation Service system, not the system itself, has been borrowed and applied to the situation in Vosberg Valley. This has been necessary because their system is geared toward present-day, sophisticated agricultural method and technique. However, prehistoric agriculturalists were confronted with problems on a different scale and in different contexts, and this requires some modification in the kinds of dimensions considered important. For instance, in the Soil Conservation Service scheme, sloping land is regarded as a negative factor. It was argued previously that, to the contrary, prehistoric agriculturalists in Vosberg Valley would have found it advantageous to use sloping surfaces for field locations because of favorable soil, temperature, and moisture conditions. Since the criteria employed here are different from those used by the Soil Conservation Service, it is necessary to include a brief discussion of the methods by which land-capability classes were established in the present study.

There are three ranked dimensions to be simultaneously considered in establishing land-capability classes: edaphic zone, hydrographic zone, and slope angle-facing zone. Probably the most expedient and clearest method of dealing with the multi-dimensionallity involved in setting up different classes is a graphic model in which each dimension with its ranked subclasses is considered as one axis of a spatial unit having three dimensions, as depicted in figure 20. In this figure, the highest ranked soil zone is placed at the top of the vertical axis and the lowest is at the bottom; the highest ranked hydrographic zone is to the left and the lowest ranked is to the right; and the highest ranked slope angle-facing zone is toward the front while the lowest is toward the rear. Rank orders used along each dimension are those established in tables 16, 15 and 14 respectively.

Together the three axes define the center skeleton of a cubic unit of space which, when filled in, is partitioned into eight subspace units. Each subspace unit of the cube, lettered A through H, represents a land-capability class with its own unique properties (figure 21). The subclasses of each dimension which define any given land-capability class are listed along the portions of each central axis pertaining to that subspace unit.

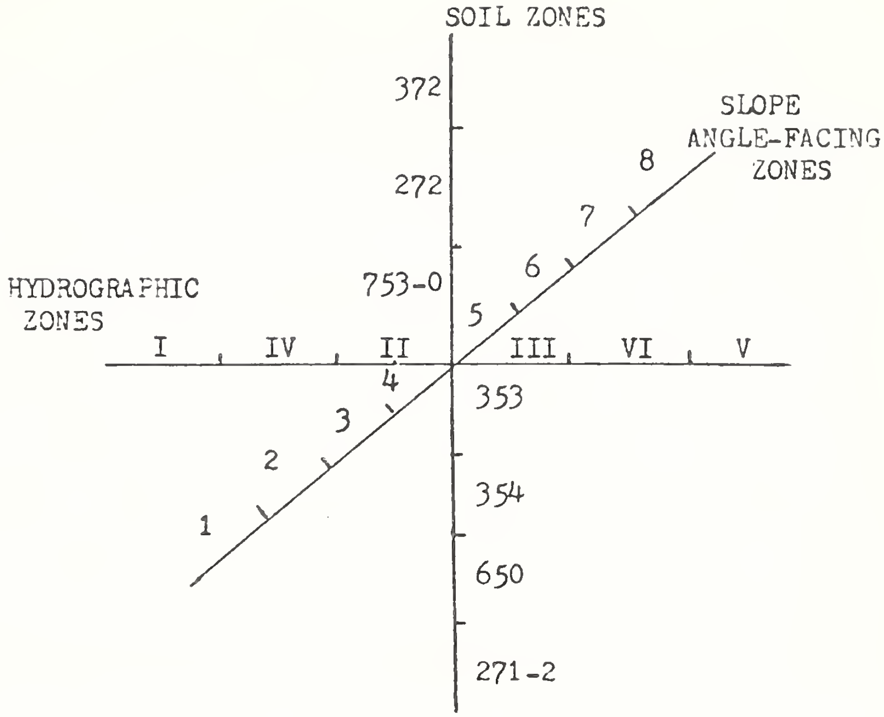


Figure 20. Environmental axes used to define land-capability classes

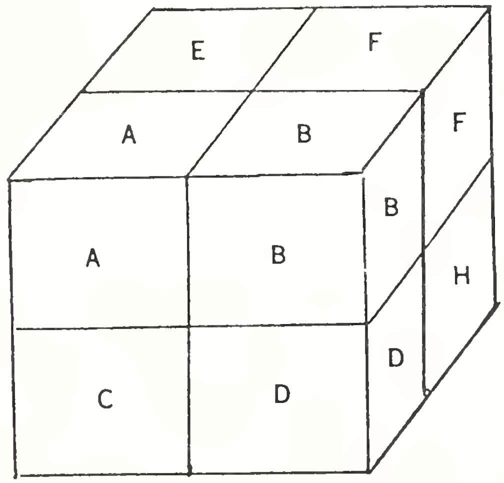


Figure 21. Cubic spatial representation of land-capability classes

It is now necessary to determine which dimensions and subclasses should be given the greatest weight in formulating land-capability classes. Since soil provides the greatest variety of vital requirements for plants, including ". . . anchorage, a supply of water, mineral nutrients, and aeration of their roots" (Oosting 1956:178), the higher ranking subclasses of this dimension are given precedence over the higher ranking subclasses of the other two dimensions. The higher ranking hydrographic subclasses are then given precedence over those of slope angle-facing because the relationship between plants and their water supply is considered more critical than that between plants and minor topographic variation. Thus, subspace unit A, defined by a combination of the highest ranking subclasses of all dimensions, forms the highest ranked land-capability class. Next in rank order is subspace unit E because it is defined by the highest ranking soil subclasses in combination with the highest ranking hydrographic subclasses and the lowest ranking slope angle-facing subclasses. This same rationale is carried over into the lower ranking subclasses of each dimension until each subspace unit is assigned a rank ordering.

The preceding procedures generate a hierarchical arrangement of land-capability classes as follows:

Class A Land-- This is the class with the highest agricultural potential. It includes all land with any combination of moderate to highly productive soil types 372, 272, or 753-0 and slope angles of 15+ percent or 15-10 percent with any of the possible facings, located in hydrographic zones I, IV, or II.

Class E Land-- The same condition of soil types and hydrographic subclasses pertain to class E land as are found with class A land. The difference is that these lands may be located in one of the lower ranked slope angle-facing zones.

Class B Land-- Third highest in agricultural potential is class B land. It is composed of plots having one of the higher ranked soil types in combination with one of the more desirable slope angle-facing, located in any of the three lowest ranked hydrographic zones.

Class C Land-- This class is formed by any combination of the lower ranked soil subclasses and the higher ranked hydrographic and slope angle-facing subclasses.

Class F Land-- Class F lands have the three higher ranked soil types in combination with the lower ranking subclasses of both the hydrographic and slope angle-facing dimensions.

Class G Land-- Class G lands have some combination of any of the least desirable soil types and the lowest ranked slope angle-facing subclasses, but are located in the better hydrographic zones.

Class D Land-- This land has the poorer soil types, is in the lowest ranked hydrographic subclasses, but is situated on the higher ranked slope angle-facing lands.

Class H Lands-- This is the land-capability class with the least agricultural potential. Its constituent lands have some combination of all of the least desirable dimension subclasses.

The above land-capability classes are scattered around the valley in large, small, and very small plots, and in an effort to render a unified representation of the lands pertaining to each class, a map was partially prepared showing the various environmental zones from figures 14, 16, 17, and 19 superimposed one on another. But this map became illegible even before all slope-facing and slope angle zones were entered; therefore, it has not been possible to show land-capability classes on a single map. By expanding the map to an extremely large scale and using different colors for different dimensions, it was possible to produce a rough working map from which close quantitative estimates of the amount of land in each capability class were derived (table 17). Combining the areas for the two highest ranked land-capability classes and dividing by the total of all areas disclosed that only 7 percent of the available land is in these two classes, thus supporting Secondary Hypothesis III.

Table 17

AMOUNT OF LAND PER LAND-CAPABILITY CLASS

Land-Capability Class	A	E	B	C	F	G	D	H
Aeral Coverage - km^2	0.56	0.06	1.17	1.04	0.34	2.85	0.71	1.96

Site Location and Survey Transects

It was mentioned earlier that, during site relocation and reevaluation in 1974, a number of previously unrecorded sites were discovered; and it soon became apparent that intensive resurvey would be necessary. For this purpose, two transects were selected, the size of which were determined by available time and personnel. However, selection of transect locations, having been made at a time when the present research was still in an initial stage, was based upon data available at that time. This was limited to several microenvironmental zonation maps prepared by Chenhall (1972). Microenvironmental zones were established by Chenhall on the basis of distinctions in topography, slope angle, slope direction, and vegetation. The pattern of these zones is quite complex, but transects were selected with the intent of encompassing as much microenvironmental variability as possible. One purpose for establishing the transects was to provide a mechanism for checking the accuracy of site density data available from previous survey.

The two transect locations selected cut across the valley at an angle approximately 20° off a due east-west line (figure 22). Each transect is 2000 meters long and 400 meters wide, covering a total area of 1.6 km^2. Since the entire research universe is only 10 km^2, the intensively resurveyed transects cover about 16 percent of the total area. Prior to the 1974 resurvey, there were six sites recorded within the area bounded by the northern transect and nine sites within the southern transect. Intensive resurvey increased the site total to 11 in the northern transect and to 18 in the southern one. This suggests that intensive resurvey of the entire valley might have resulted in nearly doubling the originally recorded site number from 61 to about 120. Of course, this is a rough estimate, but should not be greatly in error.

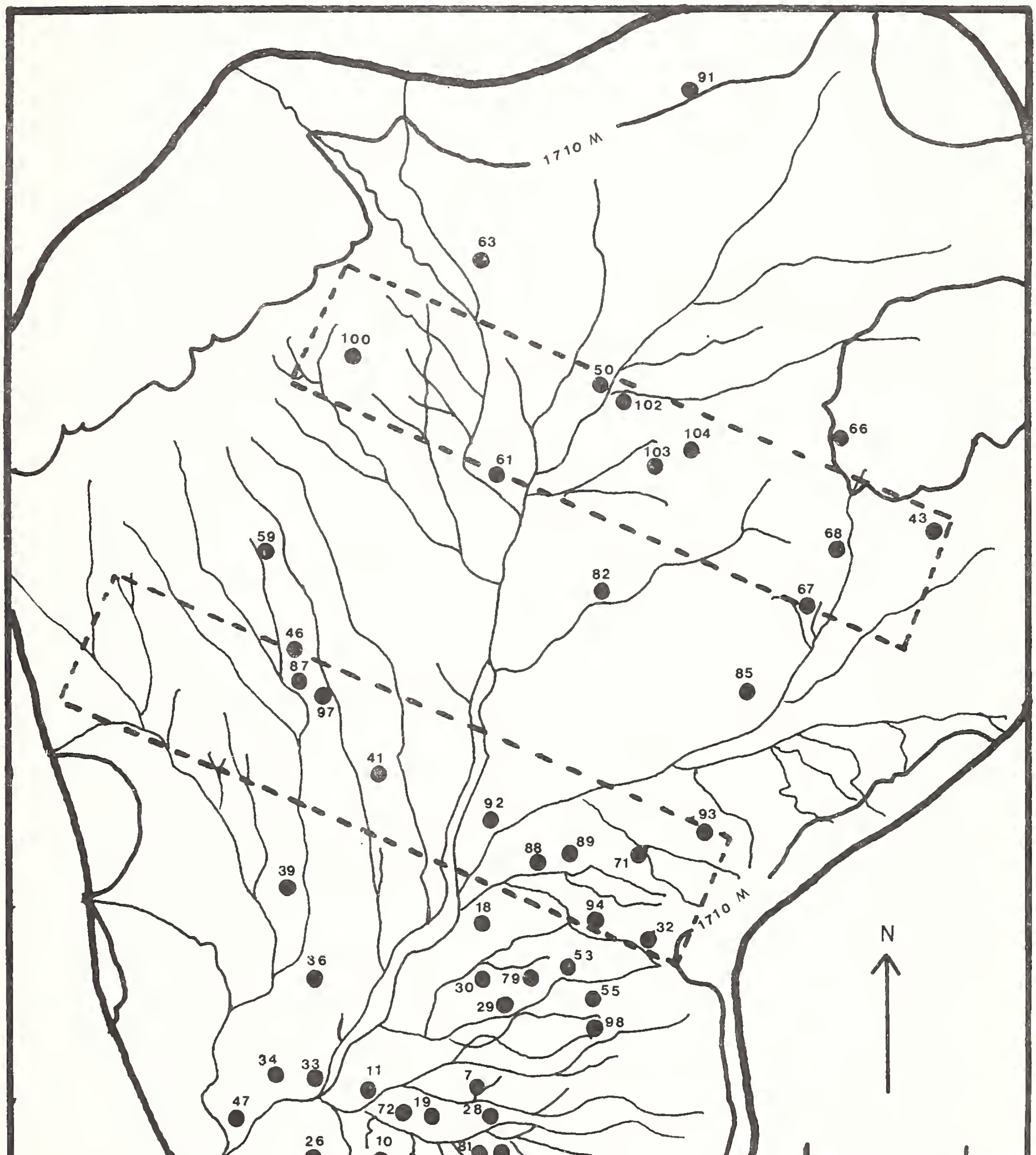


Figure 22. Survey transects and site location.

It was only during the process of detailed environmental analysis that the decision was made to establish the analytical units called land-capability classes. As the reader is aware at this point, the most important single criterion in establishing these land classes has been edaphic variability. The soil map used for this purpose was not available to Chenhall, and soil variability played no direct role in his delineation of microenvironmental zones. Thus, selection of transect locations was based upon incomplete or inadequate data, and the transects chosen do not give equal representation to each land-capability class. In fact, some of the most important soil zones from an agricultural point of view, and the land classes based upon them, are represented minimally or not at all. Soil zones have been included in figure 22 to illustrate this point.

There are 29 sites located within the boundaries of the two transects, but 10 of these do not date in the A.D. 1050 to 1250 period and have not been included in figure 22, leaving only 19 sites as the available sample for use in testing those hypotheses dealing with site location. The additional fact that some land-capability classes were not given meaningful representation presented a dilemma. On the one hand, there was well-controlled survey data from the two transects which afforded a sample of only 19 sites in relation to admittedly unrepresentative environmental categories. On the other hand, there was valley-wide environmental data and a substantially larger, but potentially unrepresentative, sample of sites. Once this problem became apparent, it would have been most advisable from an analytical perspective to return to Vosberg Valley with a sampling program designed to investigate site density per land-capability class. However, this would have necessitated waiting until the following summer to return to the field, postponing this study by almost a year. This approach was rejected.

All available, relevant site data have been used in testing hypotheses in the following section, but the reader should be aware of problems inherent in this data. While it is safely predictable that there is a substantial number of sites yet to be located in Vosberg Valley, it is the author's opinion that available site data afford a reasonable sample for use in testing hypotheses dealing with spatial distribution of sites. In the first place, there is no indication that particular areas of the valley were intentionally given less coverage vis-a-vis other areas in previous surveys. Though coverage was not adequate to judge from transect survey results, the techniques used were uniformly applied from area to area. Whatever factors may have played

a part in sites being overlooked in one area were in effect in all areas. One can thus argue that available data are proportionally representative in a spatial sense of the true population of sites in the valley. Secondly, if the actual number of sites is around 120, then the 87 recorded sites represent a 73 percent sample of the entire population. Coupled with relatively uniform spatial representation, such a large sample is considered sufficient to generate reliable inferences.

Site Location and Agricultural Potential

The locations of the 48 sites relevant to this analysis are shown in figures 14, 16, 17, and 19 plotted in relation to slope-facing, slope angle, hydrographic zone, and edaphic zone, respectively. Of the sites shown, 42 were included in the ceramic seriation completed in the demographic section of this study; but 6 had to be excluded from that seriation because of problems with available ceramic collections. Table 18 lists all 48 sites, the microenvironmental zone within which each is located, and the land-capability class pertinent to each site. The latter was determined by plotting site locations in the cubic spatial unit representing the 8 land-capability classes (figure 23). For example, the position of AZ P:13:98 in figure 23 was plotted in the following manner: reference to table 18 shows AZ P:13:98 to be located in edaphic zone 272, hydrographic zone I, and slope angle-facing zone 6. Then, referring back to figure 20, showing the position of each dimension subclass along each of the three axes, one coordinate is plotted at subclass I on the hydrographic axis and another at subclass 6 on the slope angle-facing axis. Imaginary lines extended from each of these two points, perpendicular to each horizontal axis intersect at a point within the imaginary horizontal plane shown in figure 23. A third perpendicular is then raised from this point in the plane to a height commensurate with the location of soil type 272 on the vertical soil axis. The location of AZ P:13:98 in terms of land-capability class is thus indicated by this final point falling within the subspace unit representing land-capability E. Each numbered dot in figure 23 represents the subspace location of one or more sites. For clarify of illustration, sites falling above the plane are defined by a solid line and those below the plane by a dotted line.

Table 18

LAND-CAPABILITY CLASS LOCATION OF SITES AND MICROENVIRONMENTAL ZONES

Site AZ P:13:-	Hydrographic Zone	Edaphic Zone	Slope Angle-Facing Zone	Land-Capability Class
7	I	354	3	C
10	I	272	2	A
11	I	353	7	G
18	I	353	7	G
19	I	353	7	G
26	II	272	2	A
29	I	353	5	G
30	I	353	5	G
32	I	753-0	1	A
33	II	272	2	A
34	II	650	1	C
36	II	353	5	G
39	II	353	7	G
41	II	353	7	G
46	IV	354	5	G
50	V	354	1	D
51	I	272	2	A
53	I	272	3	A
55	I	272	3	A
56	I	354	4	C
57	I	354	4	C
58	I	354	3	C
59	IV	354	3	C
61	IV	354	7	G
63	VI	753-0	3	F
66	III	372	1	E
67	III	354	5	H
68	III	372	1	E
71	I	354	3	C
73	I	354	5	G
79	I	353	3	C
80	I	354	3	C

Table 18--Continued

Site AZ P:13:-	Hydrographic Zone	Edaphic Zone	Slope Angle-Facing Zone	Land-Capability Class
81	I	354	5	G
82	IV	354	5	G
85	III	354	5	H
87	IV	354	7	G
88	I	353	5	G
89	I	354	3	C
91	V	753-0	1	B
92	II	353	7	G
93	III	354	3	D
94	I	354	3	C
97	IV	353	7	G
98	I	272	6	E
100	VI	753-0	3	B
102	V	354	4	D
103	III	354	5	H
104	III	354	5	H

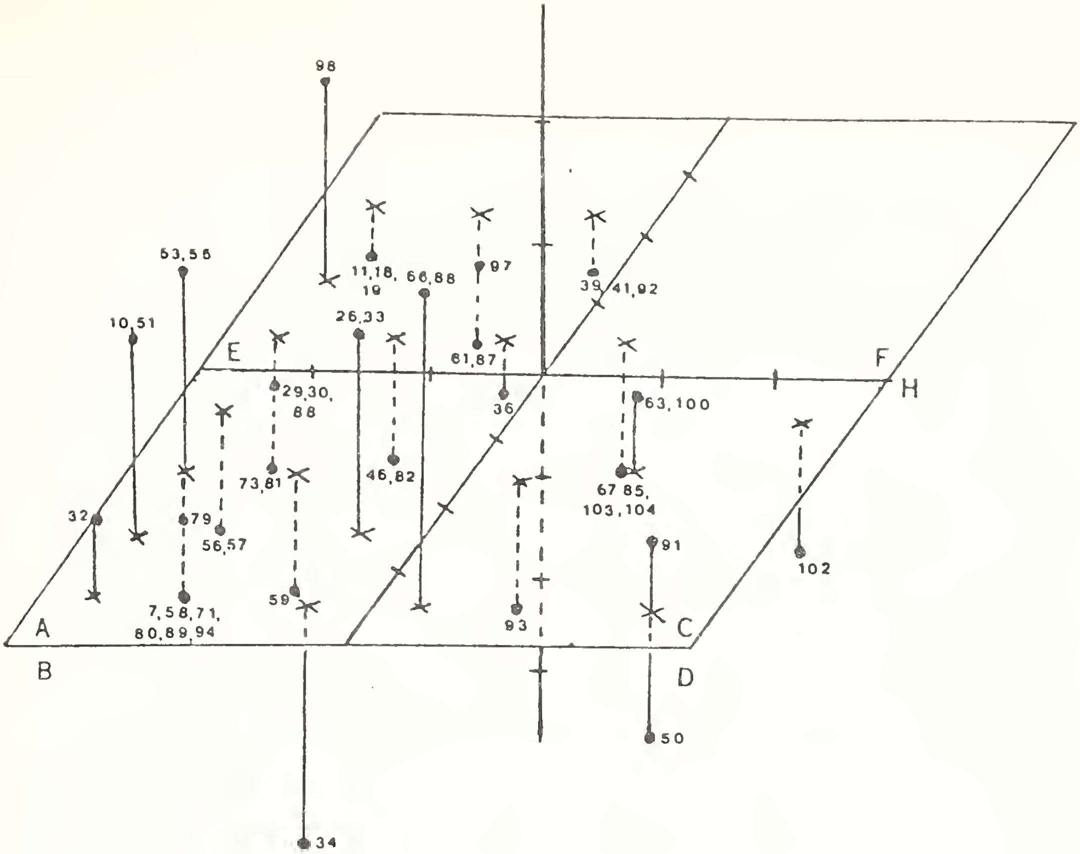


Figure 23. Land-capability classes and site location.

This method of plotting site location relative to land-capability classes affords a means of testing Secondary Hypotheses IV and V and Supportive Hypothesis II. Secondary Hypothesis IV states that the greatest numbers and/or densities of rooms are located in areas best suited to agriculture. The hypothesis is intentionally stated in terms of room numbers instead of site numbers because the principal underlying concern is with population density in relation to differential agricultural potential. If site numbers had been used as comparative units, a two-room site would carry just as much weight as a 15-room site, and population differential from site to site would be left unaccounted for. Sites and room counts for each land-capability class are given in table 19. The data from this table are then used to derive the statistics given in table 20. It can be seen in table 20 that site counts per land-capability class do not show the greatest numbers on the best agricultural lands. Converting to room counts still does not show the highest numbers on the best lands, although the correspondence is better than that based on site counts. But

Table 19

SITES AND ROOM COUNTS PER LAND-CAPABILITY CLASS

	Land-capability Class A																
AZ P:13:-	10	26	32	33	51	53	55										
Room count	8	27	2	5	3	13	2										
	Land-capability Class E																
AZ P:13:-	98																
Room count	2																
	Land-capability Class B																
AZ P:13:-	63	66	68	91	100												
Room count	2	2	20	8	1												
	Land-capability Class C																
AZ P:13:-	7	34	56	57	58	59	71	79	80	89	94						
Room count	4	27	2	2	4	15	5	3	5	5	3						
	Land-capability Class F																
AZ P:13:-	None																
Room count																	
	Land-capability Class G																
AZ P:13:-	11	18	19	29	30	36	39	41	46	61	73	81	82	87	88	92	97
Room count	5	2	2	2	1	5	4	2	3	3	1	2	4	2	3	2	4
	Land-capability Class D																
AZ P:13:-	50	93	102														
Room count	2	1	2														
	Land-capability Class H																
AZ P:13:-	67	85	103	104													
Room count	2	2	2	2													

Table 20

SITES, ROOM COUNTS, AND ROOM DENSITIES PER LAND-CAPABILITY CLASS

Land-Capability Class	Number of Sites	Number of Rooms	Areal Coverage km^2	Rooms per km^2
A	7	60	0.56	107.14
E	1	2	0.06	33.33
B	5	33	1.17	28.20
C	11	75	1.04	72.12
F	0	0	0.34	00.00
G	17	47	2.85	16.49
D	3	5	0.71	7.04
H	4	8	1.96	4.08

when one calculates a density statistic of rooms per square kilometer for each land-capability class, there is a clear, marked concentration of rooms on class A land. The density statistic in this case is 107.14 rooms per km^2, far in excess of that of any other land class. Finally, equating room density with population density establishes class A land as that having the greatest concentration of population, thus clearly supporting Secondary Hypothesis IV.

Though the association between land with the greatest agricultural potential and the highest population concentration is evident, one might also be interested in the correlation between the remaining land classes and the remaining room density or population statistics. Since both variables can be ranked, it is possible, through application of Kendall's rank correlation coefficient (Siegel 1956:213-223), to derive a measure of association between them. In order to accomplish this, land-capability classes are first arranged in their descending rank order as in table 21. Room density rank categories are then placed in the columns appropriate to each land-capability class. The null hypothesis in tests of correlation is that there is no association between the variables being compared. In this particular case, the coefficient of agreement was calculated at 0.67, making it possible to reject the null hypothesis at the level of significance

of 0.016. It is concluded that the observed association is not the result of chance but rather a genuine relation between agricultural potential and population concentration.

Table 21

AGRICULTURAL POTENTIAL VS. POPULATION CONCENTRATION

Land-capability class	A	E	B	C	F	G	D	H
Agricultural Potential Rank	1	2	3	4	5	6	7	8
Population Concentration Rank	1	3	4	2	8	5	6	7

Given the dichotomy between land of good agricultural potential and land of poor agricultural potential, it seems reasonable to propose that people situated in poorer agricultural locales in Vosberg Valley would find it necessary to depend slightly more on hunting to supplement their food supplies than those who were situated on better agricultural lands and whose crops were more dependable, and that such differences in subsistence emphasis should be reflected in tool inventories. Specifically, sites in poorer agricultural situations should have higher ratios of hunting-related tools to agriculture-related tools than sites in better agricultural situations (Supportive Hypothesis II).

This notion can be tested by comparing tool ratios between sites located on lands with differing agricultural potential; but, because the number of sites pertaining to individual land-capability classes is small, it is appropriate to combine the data into two larger groups, one comprised of the four highest ranked classes, A, E, B, and C, containing 24 sites, and another comprised of the four lowest ranked classes, F, G, D, and H, also containing 24 sites. This procedure increases the sample size in each group to a statistically meaningful level. The 48 sites under analysis appear in table 22, arranged in the two groups thus formed. For purposes of this comparison, a simple dichotomy is drawn between hunting tasks and agricultural

Table 22

AGRICULTURAL-HUNTING TOOL RATIOS
IN SURFACE COLLECTIONS

Sites in Better Agricultural Locales							Sites in Poorer Agricultural Locales						
Site AZ P:13:-	Manos	Metates	Hoes	Knives	Projectile points	Agricult./hunting tool ratio	Site AZ P:13:-	Manos	Metates	Hoes	Knives	Projectile points	Agricult./hunting tool ratio
7	-	-	-	-	-	+*	11	-	-	-	-	-	+
10	4	1	-	-	5	+	18	-	-	-	-	4	0
26	1	-	-	-	16	0	19	1	-	-	-	-	+
32	1	-	-	1	1	0	29	-	-	-	-	1	0
33	-	-	-	-	7	0	30	1	-	-	-	-	+
34	-	1	1	-	3	0	36	-	-	-	1	3	0
51	1	1	-	-	2	+	39	-	-	-	-	2	0
53	2	-	-	-	2	+	41	9	-	-	-	12	0
55	-	-	-	-	-	+	46	2	1	-	2	5	0
56	-	-	-	-	-	+	50	-	-	-	1	2	0
57	-	-	-	-	6	0	61	-	-	-	-	1	0
58	-	-	-	-	-	+	67	-	-	-	-	2	0
59	1	1	-	-	4	0	73	1	1	-	-	-	+
63	-	-	-	-	2	0	81	-	-	-	-	1	0
66	1	-	-	-	1	+	82	-	-	-	-	-	+
68	1	-	-	-	1	+	85	1	-	-	-	-	+

Table 22--Continued

Sites in Better Agricultural Locales							Sites in Poorer Agricultural Locales						
Site AZ P:13:-	Manos	Metates	Hoes	Knives	Projectile points	Agricult. /hunting tool ratio	Site AZ P:13:-	Manos	Metates	Hoes	Knives	Projectile points	Agricult. /hunting tool ratio
71	3	1	-	-	1	+	87	-	-	-	-	3	0
79	1	-	-	-	-	+	88	-	-	-	-	1	0
80	1	-	-	-	1	+	92	1	-	-	-	2	0
89	1	1	-	-	4	0	93	-	-	-	-	2	0
91	-	-	-	-	1	0	97	-	1	-	-	5	0
94	1	-	-	-	-	+	102	-	-	-	-	-	+
98	-	-	-	-	-	+	103	-	-	-	-	1	0
100	1	-	-	-	-	+	104	-	-	-	-	4	0

*"+" indicates agricultural-to-hunting tool ratio of 1:1 or greater.
"0" indicates agricultural-to-hunting tool ratio of less than 1:1.

tasks. Identified, surface collected tools which were used primarily in the former kinds of tasks are knives and projectile points, and those used primarily in the latter kinds of tasks are manos, metates, and hoes. Quantities of these items per site have also been given in table 22. The final column for each section of this table expresses the agricultural-to-hunting tool ratio as a "+" or a "0." The "+" indicates a relatively greater quantity of agricultural tools or equivalent numbers of both types (1:1 or greater); the "0" indicates a relatively greater quantity of hunting tools (less than 1:1).

Surface collections from five of the sites in better agricultural locales and three of the sites in poorer agricultural locales yielded no tools in either category. Of the remaining sites in better locales, 53 percent have agricultural-to-hunting tool ratios of 1:1 or greater, while 47 percent have ratios of less than 1:1. That is, 53 percent have relatively more agricultural tools or equivalent numbers of agricultural and hunting tools, showing a slight tendency for agricultural tools to be more prevalent at sites in better agricultural situations. Turning to the sites in poorer agricultural situations, 19 percent have relatively more agricultural tools or equivalent numbers of both types of tools, while 81 percent have relatively more hunting tools, showing association between prevalence of hunting tools and location in poorer agricultural areas.

The significance of this variation in tool type ratios can be evaluated using a difference of proportions test (Blalock 1972:228-232). The null hypothesis is that the proportions of agricultural-to-hunting tool ratios are equivalent in the two populations. Since the original hypothesis not only predicts that there is a significant difference in this respect, but also predicts the direction of this difference, a one-tailed test is appropriate. A significance level of 0.05 was selected, and a $\underline{Z}$ statistic of 2.27 was calculated according to procedures outlined by Blalock (1972:229-230). The one-tailed probability of obtaining a $\underline{Z}$ value as large as or larger than 2.27 is 0.01, and the null hypothesis can be rejected. It is concluded that sites in poorer agricultural locales show greater dependence on hunting activities than sites in better agricultural locales, as evidenced through tool types present on the surface.

The relationship between site location and lands of differing agricultural potential is the basis of yet another hypothesis. Secondary Hypothesis V states that sites temporally near the middle of the sequence are generally located in areas of poorer agricultural

potential than are those dating to either end of the sequence. For purposes of hypothesis testing, the sequence of 42 sites, established through ceramic seriation, can be broken into three groups, each containing 14 sites, and each of which equates with one of the time segments defined in Secondary Hypothesis V (table 23). That is, the first 14 sites in the series represent the early part of the sequence, the second 14 represent the middle part, and the last 14 represent the late part. However, instead of using the eight original land-capability classes, each having a small number of associated sites, it is necessary, once more, to lump land classes into two larger groups containing the four higher and four lower ranked classes respectively in order to obtain samples sufficiently large to allow statistical evaluation. The four highest ranked classes are represented by "+" in table 23, and the four lowest ranked classes by "0."

Each of the three columns of sites in the table can be treated as a different sample drawn from a two-class population. Then, with land classes defined as a dichotomous variable, there is a 0.5 probability that any selected site will fall into either class. Data arranged in this fashion is amenable to application of the binomial test (Siegel 1956:36-42). If there is no correlation between site location and land-capability class through time, "+" and "0" symbols should be about equally represented in each column. More specifically, if Secondary Hypothesis V is correct, we should expect a significantly high number of "+" symbols in both the early and late columns and either equal representation of both symbols or significantly higher numbers of "0" symbols in the intermediate column. Thus, the null hypothesis is one of no difference in which it is held that observed proportions can be accounted for by chance sampling variation. To test this hypothesis, a significance level of 0.05 was selected.

In the early column, 6 out of 14 sites are seen to be located on the higher ranked land-capability classes, refuting that portion of the hypothesis which predicted significantly higher numbers of sites in such situations. In the intermediate column, 5 out of 14 sites are located on the higher ranked land classes. Since it was predicted in this case that sites might be equally distributed between good and poor agricultural lands, the second portion of Secondary Hypothesis V is supported. In the late column, 11 out of 14 sites are situated in better agricultural locales, and reference to a table of probabilities for the binomial test (Siegel 1956:table D) indicates that, for a two-class population, such a distribution could occur with a probability

Table 23

EARLY, INTERMEDIATE, AND LATE SITES
PER LAND-CAPABILITY CLASS

Early Sites AZ P:13:-	Land Class Location	Intermediate Sites AZ P:13:-	Land Class Location	Late Sites AZ P:13:-	Land Class Location
93	0*	55	+	33	+
104	0	39	0	67	0
88	0	102	0	79	+
94	+	36	0	71	+
61	0	32	+	10	+
92	0	46	0	26	+
50	0	97	0	19	0
57	+	91	+	51	+
100	+	87	0	34	+
41	0	53	+	11	0
98	+	73	0	68	+
66	+	103	0	80	+
63	+	59	+	89	+
30	0	81	0	58	+

*"+" indicates one of the four higher ranked land-capability classes.
"0" indicates one of the four lower ranked land-capability classes.

of only 0.029. The null hypothesis can thus be rejected, and it is concluded that sites in the late part of the sequence do correlate with locations on the better agricultural land, supporting the predicted relationship.

An association between site location and better agricultural situations could not be demonstrated in the case of the early sites, and one could argue that, apparently, preferential selection for the best agricultural land did not take place during the early part of the period. However, one could also argue that the sites listed in the "early" column of table 23 are not, in fact, representative of the early sites of the A.D. 1050 to 1250 period. Large, late sites may be superimposed on, or be the result of in situ growth of, early sites. Indeed, this is to be expected if Secondary Hypothesis V is essentially correct. Early sites, if located on the best land, should have been the ones to persist and grow by virtue of their more dependable food supplies, and they would have been occupied throughout the entire period. But, surface collections from these sites would recover mostly ceramics from their intensive late occupations. When seriated, these sites would appear to be late in the sequence despite the occurrence of less intensive earlier occupations poorly represented in surface collections. The presence of superimposed floors at the two large sites which were excavated (AZ P:13:10 and AZ P:13:26) suggests that the latter argument may be valid.

Secondary Hypothesis VI predicts that data indicative of technological intensification of agricultural practices are more prevalent and/or more elaborate in the last half of the A.D. 1050 to 1250 period than in the first half. Throughout the preceding analyses, it has been implicitly assumed that habitation site location was coincident with location of agricultural fields; i.e., it has been assumed that agriculture was conducted in the immediate vicinity of habitation sites. That this assumption is not unfounded is indicated by spatial associations between habitation sites and various agricultural elements, such as check dams, ridge walls, and diversion walls, defined by Rodgers (1970) and discussed briefly in chapter II. The presence of such agricultural elements was recorded at 18 sites in Vosberg Valley, 14 of which date in the A.D. 1050 to 1250 period. Agricultural elements and habitation rooms are in direct spatial association at 10 of these 14 sites. In 2 other cases, agricultural elements are very near habitation structures, and association can

be reasonably inferred. Thus, out of the 14 recorded cases dated appropriately, there are 12 in which agriculture was apparently conducted in the immediate vicinity of the living area.

Since agricultural elements were recorded at only 12 habitation sites, it is evident that a majority of such sites had no associated agricultural elements, but we need not necessarily expect evidence of agricultural practices at many sites. Agricultural elements of the kind constructed by Vosberg's prehistoric agriculturalists were sometimes quite minimal, consisting of no more than a few boulders or cobbles arranged in a row to retard the movement of soil and/or water. Even if such rock alignments should have remained intact after hundreds of years, they can be easily overlooked by surveyors, especially in an area like Vosberg Valley with its heavy growth of manzanita and cat claw in many areas. Furthermore, when a suspicious line of rocks is observed, except in unquestionable cases, there is no infallible means of deciding whether it is a natural or man-made feature. It must also be recognized that it is possible to retard the movement of soil and water with perishable structures such as brush piles and small earthen dams, and that there are local conditions under which agricultural plots could have been established without the need of any kind of retaining structure. Thus, the many sites lacking evidence of associated agricultural elements do not invalidate the assumption that agriculture was practiced in the immediate vicinity of habitation sites.

The 14 sites with associated agricultural elements and a description of these elements are listed in table 24. Four of the site numbers listed here have not been mentioned previously; these are AZ P:13:28, AZ P:13:43, AZ P:13:47, and AZ P:13:72. All four sites are comprised of only agricultural elements, sufficiently isolated in space to have warranted separate numbers during survey; but each of them can be linked to habitation sites on the basis of probable association. The nearest habitation sites to AZ P:13:28, AZ P:13:43, and AZ P:13:72 are AZ P:13:7, AZ P:13:68, and AZ P:13:19, respectively. AZ P:13:47 is closest to AZ P:13:26 but is much more readily accessible from AZ P:13:34 and is, therefore, considered to be associated with the latter site.

Table 24 is first subdivided on the basis of sites which were included in seriation procedures and those which were not included. AZ P:13:43, AZ P:13:47, and AZ P:13:72 have been given a chronological position among the seriated sites in accordance with associated, seriated

Table 24

VOSBERG SITES WITH ASSOCIATED AGRICULTURAL ELEMENTS

Time	Site AZ P:13:-	Description of Agricultural Elements
		Seriated Sites
Early Half of Sequence	88	Small system of diversion walls and garden plot borders.
	57	A single check dam.
	39	Small system of ridge walls, diversion walls, and garden plot borders.
Late Half of Sequence	53	Check dams.
	103	Check dam or single garden plot border?
	59	A single check dam.
	33	Small system of diversion walls and garden plot borders.
	10	Small system of diversion walls and garden plot borders.
	72	Fairly large system of various elements including ridge walls, diversion walls, and garden plot borders. (Spatially associated with AZ P:13:19)
	51	Check dams.
	47	Largest, most elaborate system recorded; consists of various elements including check dams, ridge walls, diversion walls, and numerous garden plots enclosed in rock outlined borders. (Most accessible from AZ P:13:34)
	43	Fairly large system of various elements including ridge walls, diversion walls, and garden plots enclosed in rock outlined borders. (Spatially associated with AZ P:13:68)
		Sites Not Seriated
	28	A single, large diversion wall. (Spatially associated with AZ P:13:7)
	29	Small system of diversion walls and garden plot borders.

habitation sites. Sites excluded from seriation are AZ P:13:29 and AZ P:13:28 which is associated with AZ P:13:7. The reasons for excluding sites from seriation procedures were discussed previously. Seriated sites in table 24 are further subdivided according to whether they date in the first or second half of the A. D. 1050 to 1250 period.

A comparison of the two halves of the sequence shows that sites with associated agricultural elements or systems are three times more common in the late half. In addition, agricultural systems are the most elaborate and the largest in the late half of the A. D. 1050 to 1250 period. The increased number and complexity of agricultural systems during the second half of the sequence clearly supports Secondary Hypothesis VI.

CHAPTER VI

SUMMARY AND CONCLUDING REMARKS

The preceding analyses have examined the archeological record of the Vosberg locality, a small valley in the mountains of central Arizona, during the time period from A.D. 1050 to 1250. Several seasons of field work in the valley led Dittert (personal communication) to suggest that, when this period began, the pattern of settlement was one in which small sites having minimal numbers of individual structures were scattered at various locations in the valley. As the period progressed, a pattern of aggregation began to emerge such that, by the date of A.D. 1250, the intra-community pattern was one in which individual structures were arranged in relatively large groups of aligned, contiguous units. Dittert has further suggested that increasing site size was accompanied by increasing selection of hill-slope situations for site location.

The appearance, through time, of sites at which more and more dwelling units came to be concentrated at any one locus is defined, in the present study, as a change in co-residence patterns. The principal goal of this study has been explanation of that change. Why did the prehistoric people in Vosberg Valley begin to reside together in large groups? Why did they not simply continue to live as their predecessors had? A hypothetical explanation for changing co-residence patterns was formulated in general terms as follows: The prehistoric people in Vosberg Valley were dependent primarily upon agriculture for their subsistence. However, interrelationships among physical environmental conditions of climate, topography, hydrography, and soils in Vosberg Valley produced a situation in which agriculturally suitable land occurred as scattered, small plots; and land which was optimal for production of reasonably good crops was limited in quantity. When the valley's population was relatively small, newly formed family units budded off from parent units, settled at a suitable location, and started their own agricultural plots. The pattern of settlement in scattered, small sites which resulted was fostered by the spatial distribution of productive agricultural land. As natural population growth continued to occur, eventually the most productive agricultural niches came to be occupied, and newly forming family units had to settle on ever more marginal land. As suitable land became less readily available, some newly forming family units began to remain at the locus of

those parent units situated in locales where physical conditions would permit intensification of production. The settlement pattern which emerged under these circumstances was one of large, aggregated sites situated on the most productive land and smaller sites situated at agriculturally more marginal locales.

Because of the general nature of this hypothesis, it was necessary to formulate several secondary hypotheses which could be directly tested using available data. Each secondary hypothesis was designed to test one of the principal propositions presented in the major hypothesis.

Initially, there was a need to establish whether or not the sites being used in various analytical procedures were functionally equivalent. Chenhall (1972) has proposed that Vosberg Valley sites with five or less rooms functioned as field houses and that those with more than five rooms were habitation centers; i.e., that size differences could be attributed to functional differences and not to temporal change. Secondary Hypothesis I states that small sites and large sites were not functionally different but differed only in numbers of rooms present and arrangement of these rooms vis-a-vis one another, and that architectural features at sites of both sizes represent full-time habitation rooms with comparable social groups in residence in each individual structure.

Several tests were made of this hypothesis using data from excavated sites. All rooms of large and small sites were first compared for consistency and comparability in structure attributes. Comparability was found in attributes such as construction in pits, room shape, floor area, lining of perimeters with stone, fire pit location, and entrance location. Only with regard to internal pit features was there a noticeable difference, in that pits were larger and more prevalent in rooms at large sites. However, it is felt that in none of the rooms was there sufficient total pit capacity to suggest that these pits functioned as storage receptacles. All pits in all rooms were relatively small, and some were ash filled. Consequently, the meaning of differences in pit capacity between rooms of large and small sites could not be determined; but this single instance of noncomparability is not considered adequate to indicate functional differences, given the numerous correspondences in other room attributes.

As a second means of establishing functional similarity or difference, materials recovered from those rooms where quantitative data could be obtained were first grouped into seven functional categories and then compared between all possible room pair combinations using chi-square tests. From a total of 33 different pair combinations, only a single paring of rooms contained assemblages showing enough quantitative similarity to be considered functionally equivalent; this would mean that none of the other seven rooms compared were functionally equivalent to any other room. This surprising conclusion was rejected as extremely improbable, and it was suggested that such an unlikely outcome could be attributed to the unsatisfactory nature of the data which had to be used in making comparisons.

A comparison of all excavated rooms disclosed that materials representative of each of the seven functional categories used in the preceding chi-square comparisons were present in every room, indicating that a full range of comparable activities was carried out in rooms of large and small sites alike. Analysis of noneconomic pollen data indicated none of the sorts of distinctions which might be expected had there been differences in seasonal occupation of rooms at large and small sites. However, another comparison of bowl-to-jar ratios revealed a marked difference between a single room at one small site (the only one for which data was available) and 10 rooms at two large sites.

Finally, mean room floor area for all excavated rooms was statistically compared to mean room floor area for a sample of rooms drawn from various regions of the North American continent. The latter sample was comprised of several thousand rooms reported to have housed nuclear family social units. This comparison disclosed no significant difference between the two samples; and, combining this finding with the earlier finding that a full range of functional activities was indicated for all excavated rooms, it was argued that rooms of Vosberg Valley's large and small sites were built to accommodate nuclear family social units.

Unfortunately, the preceding analyses do not lead to an unequivocal conclusion concerning the question of functional equivalence or difference between rooms of small and large sites, as was discussed in chapter V following Test Implication IB, but the evidence favors an interpretation in the direction of the former. The two definite contraindications (room floor pit capacity and bowl-to-jar ratios) are not considered sufficient to warrant a conclusion that rooms of large and small sites functioned in different manners.

The question of population increase during the A.D. 1050 to 1250 period was next addressed. Seriation of ceramics was used to establish a seriation of habitation sites, which documented evidence of increasing room numbers through time. Then population numbers were directly equated with increasing numbers of habitation rooms and strong support was found for the prediction of a significant population during the period (Secondary Hypothesis II).

Secondary Hypothesis III predicts that variability in physical environmental factors in Vosberg Valley produced a pattern of scattered plots having a range of agricultural potential, and that good agricultural lands were present in limited amounts. This proposition was investigated by first examining the nature of climate in the Vosberg area, and it was argued that the entire region is marginal for agriculture under existing climatic conditions. Such marginality in climatic factors contributed to the necessity of locating agricultural plots in situations having favorable conditions of topography, hydrography, and soils. Analyses of the latter three environmental dimensions disclosed ample evidence to support the proposition of agriculturally significant variability across the valley. Topographic, hydrographic, and edaphic dimensions were then combined to form analytical units called land-capability classes. Altogether, eight land-capability classes, hierarchically ranked in terms of agricultural potential, were recognized. The amount of land area per land-capability class was calculated, and it was determined that the combined area in the two highest ranked classes amounts to only 7 percent of the available agricultural land, clearly supporting the latter portion of Secondary Hypothesis III.

Land-capability class data were then used to test Secondary Hypothesis IV which states that the greatest numbers and/or densities of rooms were located in areas best suited to agriculture, indicating concentration of population in these areas. The land-capability class location of each site was first determined. Site numbers per land-capability class were then tallied and converted to room counts. A comparison of raw room counts per land class would not support Secondary Hypothesis IV; but, when raw room counts were converted to densities (rooms per km^2 of each land-capability class), the hypothesis was strongly supported. To evaluate the degree of association between all land classes and density figures, a test of rank correlation was applied; this test showed a significant correlation between increasing agricultural potential and increased concentration of population.

The next step involved an attempt to correlate site location and differential agricultural potential, adding a temporal dimension, since it was predicted in Secondary Hypothesis V that sites temporally near the middle of the sequence, considered as a whole, are generally located in areas of poorer agricultural potential than are those dating to either end of the sequence, considered as a whole. The predicted relationship was supported as regards the middle and late parts of the A.D. 1050 to 1250 period, but not for the early part. This could be interpreted to mean that the hypothesis is incorrect, but there is also a possibility that late sites are superimposed on some of the early sites, and the sample of early sites used for comparison is not adequately representative of all early sites. This problem was not resolved.

Secondary Hypothesis VI states that data indicative of technological intensification of agricultural practices are more prevalent and/or more elaborate in the last half of the A.D. 1050 to 1250 period than in the first half. In order to test this hypothesis, attention was turned to agricultural systems in the valley. Examination of an admittedly small sample of 14 agricultural systems disclosed that such systems were three times more numerous, were larger, and were much more elaborate in the late half of the period than in the early half, affording clear support of the hypothesis.

Although the preceding six hypotheses are the ones considered critical in evaluating the validity of the major hypothesis, two additional hypotheses, less directly connected to the major hypothesis, were examined as potentially supportive of its plausibility. The first of these (Supportive Hypothesis I) predicted that co-residential change in Vosberg Valley was gradual, having resulted from incremental population increase. Previous analysis of data under Secondary Hypothesis II demonstrated that population increase in Vosberg Valley was exponential rather than gradual, while temporal change in site size indicated gradual co-residential change. Thus, Supportive Hypothesis I could not be substantiated.

The prediction that sites located in areas of poorer agricultural potential were more dependent on hunting than were those situated in better agricultural locations (Supportive Hypothesis II) was tested by comparing agricultural-to-hunting tool ratios between sites of the first and second halves of the A.D. 1050 to 1250 period. A test for difference of proportions was applied which indicated significantly greater hunting tool frequencies in association with sites in poorer agricultural locales, substantiating the hypothesis.

Considered as a group, the results of the tests made of the six secondary hypotheses provide a convincing argument for the validity of the major hypothesis, despite an inability in one instance to demonstrate that early sites of the A.D. 1050 to 1250 period were located in areas of high agricultural potential. Substantiation of one of the two supportive hypotheses bolsters the argument in favor of acceptance of the major hypothesis.

Through a review of Southwestern archeological literature, it was pointed out in chapter II that aggregation, or co-residential change, occurred rather commonly and on a widespread basis in prehistoric times in the Southwestern United States. The preceding analysis has offered an explanation of this phenomenon in Vosberg Valley which differs from other explanations of aggregation suggested in the past. The idea that Southwestern populations were forced to aggregate for protection from nomadic raiders was a popular though untested "explanation" for a number of years (e.g., Steward 1937:53-54; McGregor 1965:433). More recently an often cited explanation is that deterioration of climatic conditions forced population to concentrate into areas where conditions were still conducive to agricultural practices, although I am aware of no case in which this suggestion has been systematically tested; it is simply put forth as a plausible explanation (e.g., Hill 1970a:87-96; Longacre 1968:93).

To the contrary, this study has postulated, tested, and found support for the hypothesis that co-residential change in Vosberg Valley can be explained as the outcome of population growth under a specific combination of conditioning factors. Present evidence from Vosberg Valley is not sufficient to answer the question of whether or not local climatic conditions underwent deterioration in the past, but an important aspect of the explanation offered for increasing aggregation in the case of Vosberg Valley is that it stands without the necessity of including an argument of climatic change as the causal agent or prime mover for human behavioral change. One can see how deterioration of climatic conditions might have hastened the changes which did occur, but this is not essential to the explanation.

Habitation sites in Vosberg Valley were defined in chapter II as the spatial loci of socio-economic groups, i.e., groups of people who shared space, facilities, and resources for the satisfaction of individual needs. Additionally, it was argued, following data

analysis, that the social units which inhabited individual structures at these sites, and thus comprised the constituent elements of socio-economic groups, were nuclear family households. Co-residential change which occurred in Vosberg Valley can therefore be characterized as an organizational transformation in which greater and greater numbers of nuclear family households came to inhabit individual site loci through time. Data analysis has supported the hypothesis that the underlying cause of this change had its basis in the organizational requirements fostered by the necessity to control and maintain the land needed for production of agricultural crops in a situation of population expansion. However, it cannot be argued that population growth was the cause of changes in co-residence patterns, for had there not been limited amounts of suitable agricultural land in Vosberg Valley, determined through local interrelationships between topography, hydrography, and soils, the pattern of settlement and related modes of co-residence may have persisted despite population growth. Moreover, if climatic conditions had been less marginal, suitable agricultural circumstances might have been less restricted, and population growth would have had less impact on co-residence patterns. One can also speculate that if the natural productivity of the Vosberg area had been more favorable, allowing a greater opportunity for the populace to shift its subsistence emphasis to hunting or to gathering, the impact of population growth might have been differently expressed. If substantial emigration had taken place as population expanded, the early settlement pattern may have been maintained. Had technological intensification of agricultural practices not intervened to permit greater productivity from existing agricultural plots, different changes would no doubt have taken place.

The point of the preceding speculation is that one cannot look to a single factor in assessing the causes of changing co-residence patterns in Vosberg Valley; this question is most appropriately addressed in an ecosystemic framework allowing simultaneous consideration of a number of variables. Co-residential change in Vosberg Valley was not a simple and direct outcome of population growth but resulted as population growth occurred in the context of a specific set of conditioning circumstances involving a group of people who practiced a specific type of subsistence with a given level of technological sophistication.

Due to the necessity to hold the scope of the present study to manageable proportions, only localized conditions were given consideration. However, one can see that conditions outside of Vosberg Valley may have played some role in the changes which took place within the valley. This investigation raises questions concerning the relationships between the inhabitants of Vosberg Valley and nearby, as well as more distant, groups. Why did an expanding population in the valley not spill over into adjacent valleys, maintaining established co-residential patterns? Were neighboring valleys already occupied? If so, were neighboring groups friends, foes, kinsmen, or what? Were neighboring valleys simply unsuited for people with an agricultural mode of subsistence? Were both factors in force, i.e., some valleys already occupied and some unsuited for agriculture? Although these questions were not addressed, it is acknowledged that factors other than those actually investigated under the major hypothesis may have contributed in a secondary manner to changing co-residence patterns in Vosberg Valley.

The results of this study suggest a potential general explanation for similar co-residential change in other places at other times, for when one extracts the essential elements from the major hypothesis, it will be recognized that this hypothesis actually propounds a rather basic idea. The fundamental proposition embodied in the major hypothesis is that certain aspects of human social organization, particularly group spatial arrangement and attendant behavioral characteristics, are based primarily upon economic considerations. The types of economic practices employed by a human society to obtain food, shelter, and other necessities of life constitute a causal factor in the organization of the group and determine to a large degree the numbers of people who live together and interact in day-to-day, face-to-face relationships. This is by no means a novel observation for it is generally apparent on a grand scale that the change from economies oriented toward hunting and gathering to those oriented toward agriculture signaled numerous changes toward greater complexity in human societies. However, to my knowledge, such ideas have not been convincingly demonstrated in any specific archeological context.

In the case of Vosberg Valley, it has been demonstrated that group organizational principles are causally linked through an economic medium to a host of local or perhaps regional conditions and circumstances, which, in turn, suggests that other cases of co-residential change involving aggregation into larger villages might best be

explained from this same perspective. The methodological tool which has served as a vehicle for the present inquiry is an ecological-systemic approach. If we are to get at the causes of organizational change in specific cases, then we must develop the means for investigation of the relevant economic variables as fully as possible. This includes not only technology which has been the traditional subject of inquiry for archeology, but also those other factors which were given consideration in this study, such as population figures, subsistence practices, and related factors of climate, soils, hydrography, and topography. The latter variables may or may not be the ones deemed relevant in every given context, but they suggest a worthwhile starting point.

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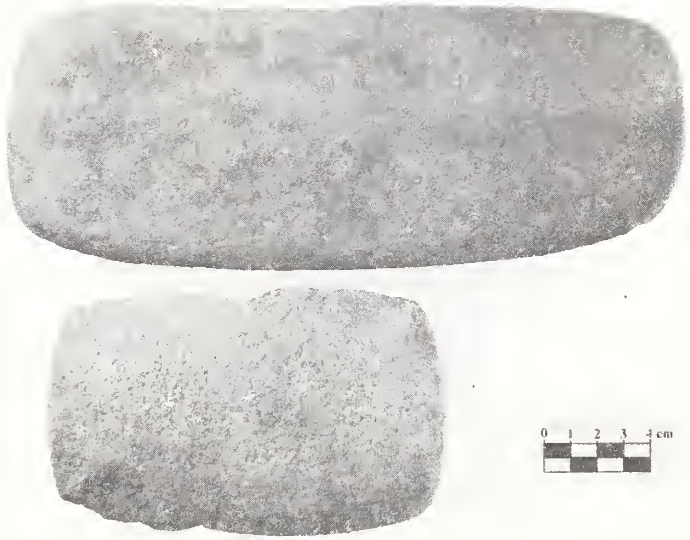
APPENDIX

PLATES OF ARTIFACTS



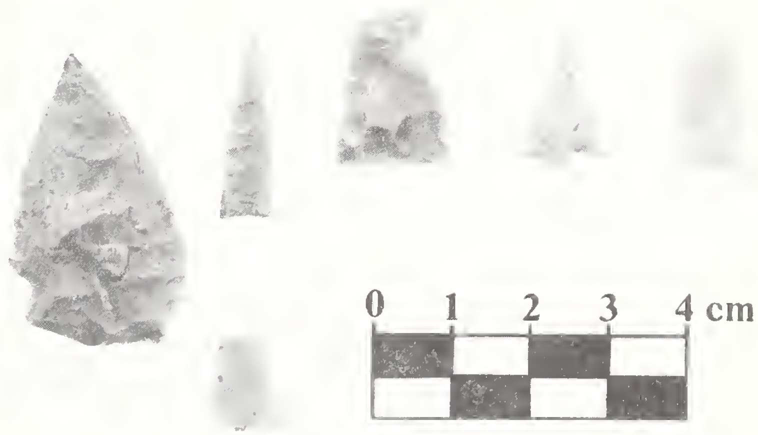
I. Manos, AZ P:13:26A and AZ P:13:10

II. Manos, AZ P:13:26A

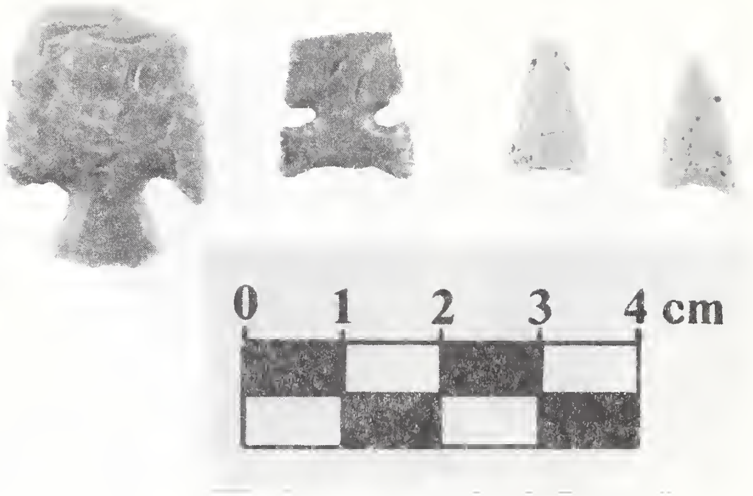
III. Hammer Stone, AZ P:13:10

IV. Projectile Points, AZ P:13:10

V. Projectile Points, AZ P:13:10



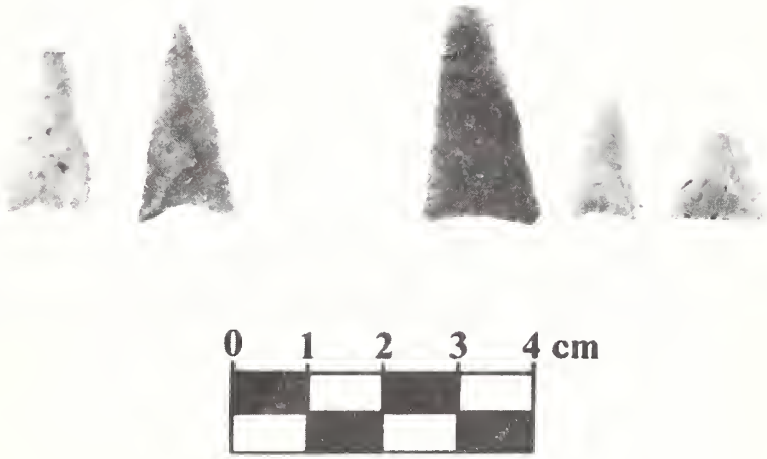
VI. Projectile Points, AZ P:13:10



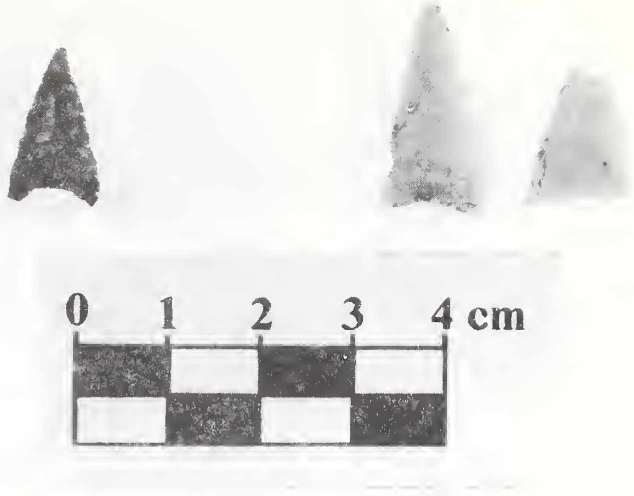
VII. Projectile Points, AZ P:13:10

VIII. Projectile Points, AZ P:13:10

IX. Projectile Points, AZ P:13:19

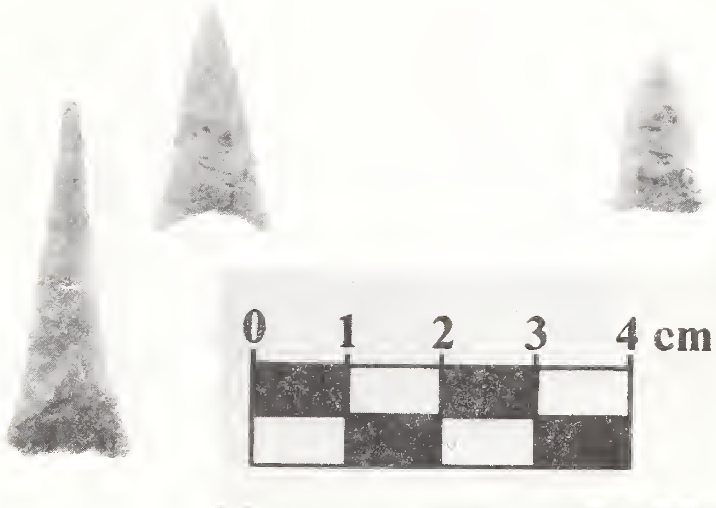


X. Projectile Points, AZ P:13:26A



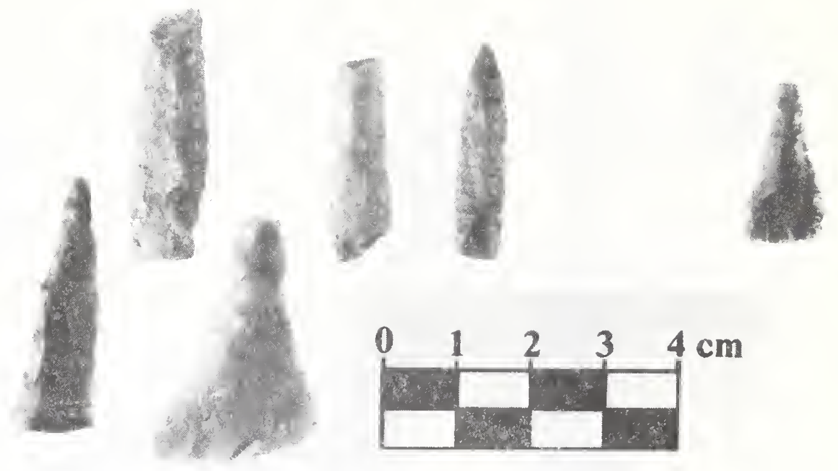
XI. Projectile Points, AZ P:13:26A

XII. Projectile Points, AZ P:13:26A

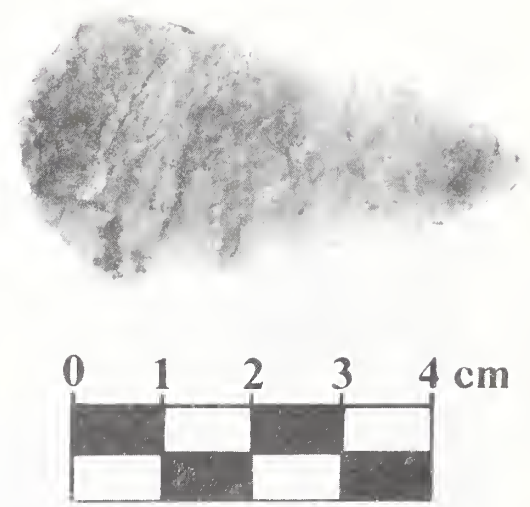


XIII. Projectile Points, AZ P:13:26B

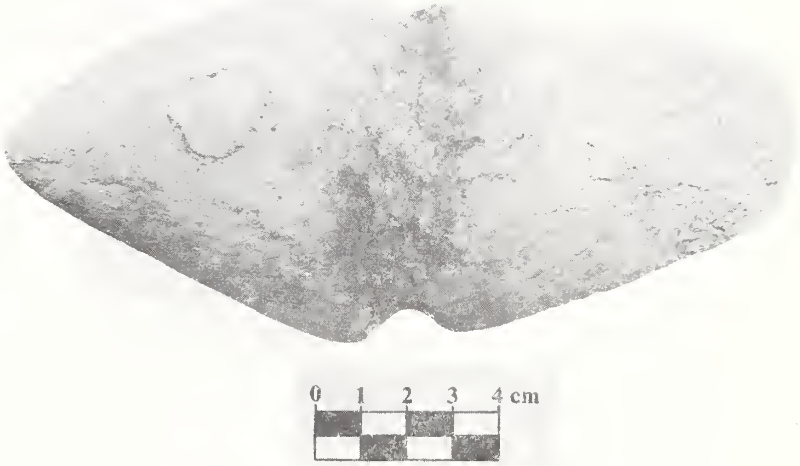
XIV. Drills, AZ P:13:10



XV. Drills, AZ P:13:10



XVI. Knife, AZ P:13:19



XVII. Double Pointed Ax, AZ P:13:10

XVIII. Three Quarter-Grooved Ax, AZ P:13:26B

XIX. Shaft Straightener, AZ P:13:10

XX. Bone Awls, AZ P:13:10 and AZ P:13:26A

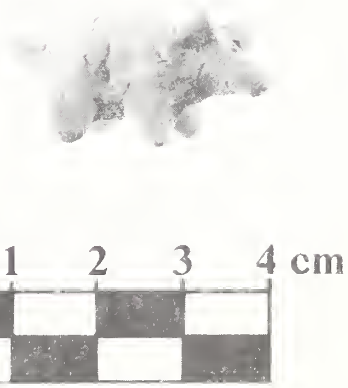
XXI. Spindle Whorls, AZ P:13:19 and AZ P:13:10

XXII. Steatite Beads, AZ P:13:26B and Steatite Ring,
AZ P:13:10

XXIII. Worked Steatite and Sandstone Disk, AZ P:13:10

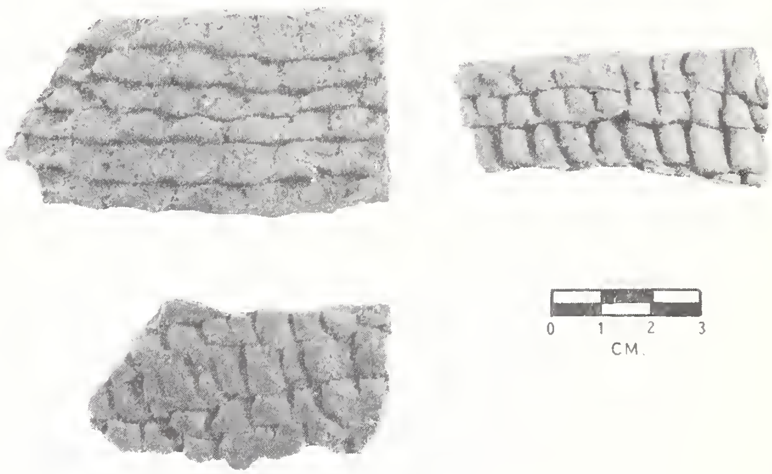
XXIV. Pendants, AZ P:13:26A

XXV. Pendants, AZ P:13:10



XXVI. Pig Figurine, AZ P:13:10

XXVII. Deer (?) Figurine, AZ P:13:10



XXVIII. Vosberg Corrugated, Slight Obliteration

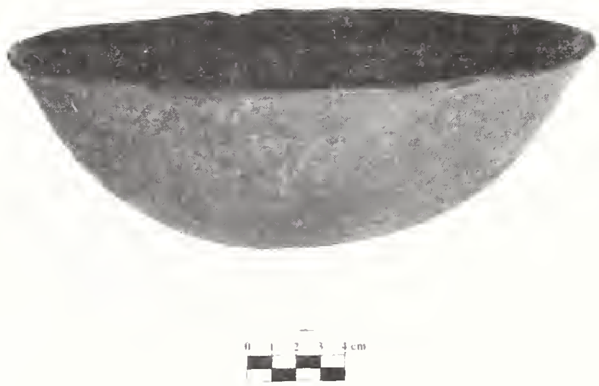
XXIX. Vosberg Corrugated, Medium Obliteration

XXX. Vosberg Corrugated, Well Obliterated

XXXI. Vosberg Corrugated Jar, AZ P:13:10

XXXII. Salado Red; Vosberg Variety Jar, AZ P:13:10

XXXIII. Salado Red; Vosberg Variety Bowl, AZ P:13:10



XXXIV. Salado Red; Vosberg Variety Bowl, AZ P:13:10

XXXV. Salado Red; Vosberg Variety Bowls, AZ P:13:10

XXXVI. Gila Polychrome Bowl, AZ P:13:10

XXXVII. Gila Polychrome Bowl, AZ P:13:10